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The Effects of Conflict on South and North Korean Economy: Evidence from Stock Market and Foreign Trade

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이종민

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이 논문을 경제학박사 학위논문으로 제출함

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Abstract

The Effects of Conflict on South and North Korean Economy: Evidence from Stock Market and Foreign Trade

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This dissertation investigates the economic impacts of international conflict, focusing on the cases of the two Koreas. Specifically, it examines the effects of North Korea-related risks on the South Korean stock market and economic sanctions on North Korea's foreign trade. It consists of three empirical studies covering subtopics.

The first chapter analyzes how South Korean stock returns respond to North Korea-related risk. To do this, a monthly index for 'geopolitical risk from North Korea' is constructed using South Korean media coverage database. The index is based on the frequency of articles containing keywords that are likely to appear in the media when inter-Korean tensions escalate or ease. Analysis of the media coverage from 1999 to 2018 show that the geopolitical risk index sharply increases in the occurrences of nuclear tests, missile launches, and military confrontations, while decreases significantly at around the times of summit meetings and multilateral talks. In the regression analysis, it is found that geopolitical risk related to North Korea has more negative effects on stock returns of firms with a higher share of domestic investors,

larger assets and a higher proportion of fixed assets. It is also found that stock prices of companies involved in inter-Korean economic cooperation exhibit a more sensitive response to the North Korea risk.

Chapter II explores the impact of economic sanctions on North Korea's foreign trade, focusing on the quality of trade. It decomposes the trade between North Korea and China into the extensive margin, relative unit price and quantity, over the periods 1998-2018. Then it estimates sanction-induced changes in the former two elements of North Korea's export to China. The decomposition results show that the growth of North Korea's export to China is mostly attributed to the growth in quantity rather than quality. In the regression analysis, sanctions imposed by South Korea, Japan and the United Nations Security Council (UNSC) are used as key treatments. It is found that the UN sanctions in 2017 reduce the extensive margin in North Korean exports, and Japanese sanctions in 2003 have lowered the relative prices of North Korean products in the Chinese import market. The price impacts of sanctions are found to be associated with the bargaining power of China over North Korea. The findings suggest that trade sanctions against North Korea have created implicit costs by preventing North Korea from trading with alternative partners and increasing reliance on China.

The last chapter estimates the size of the transit trade between North Korea and China to circumvent the sanctions imposed by South Korea. It exploits firm-product level variations in Chinese trade data to present micro evidence of the sanction-bypassing trade. Specifically, the transit trade is identified only when a firm import a product from North Korea and export the same product to South Korea in the same period. The difference-in-difference estimation results show that indirect exports from North Korea to South Korea via China are increased significantly by the "5.24 measures" in 2010. The increase in North Korea's indirect export of apparels, in particular, accounts for a 25% of the decrease in North Korea's direct exports to South Korea.

Keywords: Conflict, Geopolitical Risk, Inter-Korean Relations, Economic Sanctions, Stock Return, North Korea-China Trade, Quality of Trade, Indirect Export

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Introduction

There is a growing body of literature on the relationship between geopolitical conflicts and economic outcomes. It is uncovered that international conflicts, such as war, terrorism and territorial disputes, have adverse macroeconomic effects (Ades and Chua, 1997; Bloomberg et al., 2004; Eckstein and Tsiddon, 2004). Furthermore, they are found to reduce bilateral trade of the involved countries (Polachek, 1980; Anderton and Carter, 2001; Nitsch and Schumacher, 2004; Martin et al., 2008) and amplify the uncertainty in the stock market (Abadie and Gardeazabel, 2003; Arin et al., 2008; Berkman et al., 2011).

The case of Korea provides a valuable setting for the investigation on the economic consequences of conflicts. In 1945, with the end of World War II, Korea became independent from Japan but divided into the South and the North, and suffered from the full-scale war from 1950 to 1953. Even after the armistice agreement in 1953, the two Koreas have experienced frequent geopolitical flare-ups such as local combats and military provocations. In spite of various attempts to seek a thaw through bilateral and multilateral talks or economic engagements, there has existed a serious tension between the two Koreas. It has been accelerated recently due to North Korea's development of nuclear weapons and intercontinental ballistic missiles. Moreover, international efforts to suppress it resulted in a series of the resolutions adopted by the United Nations Security Council against North Korean economy. In this way, geopolitical conflicts around the Korean peninsula have expanded rather than subdued.

The interplay of the world's superpowers – the United States, China, Japan, and the USSR (Russia, later) – on the Korean peninsula also has led to more complex and fluid inter-Korean relationship. During the cold war, North Korea established its socialist system based on alliance with China and the USSR, and had received substantial economic aid from them. By contrast, South Korea has been developing

its economy based on capitalism and made an alliance with the US. South Korea's military capability against North Korea is also supported by the alliance between the US and Japan. These four countries are now important economic partners of South Korea, and, at the same time, the key players of geopolitics around Korea in the forms of the sanctions, arms controls, and the nuclear diplomacy.

This thesis sets out to investigate the economic consequences of geopolitical conflicts focusing on South Korean stock market and North Korea's foreign trade. It extends the existing literature in the following aspects. First, it employs the Korean case to expand understandings of the economic impacts of conflicts. I take advantage of the unique historical and geographical backgrounds of Korea to provide new evidence to the conflict literature. Moreover, the geopolitical swings around the Korean Peninsula have been induced by a series of unpredictable events, which can be exploited for causal inference.

Second, it maximizes the use of disaggregated level variations. Although a substantial number of studies have uncovered various economic reactions to geopolitical conflicts, most of them are based on cross-country or macro level analysis and much fewer studies provide micro level evidence. Through the use of micro datasets, this project contributes to the literature not only by re-examining the previous findings but also by shedding light on the possible mechanism underlying the relationship between conflict and economic outcomes.

This dissertation is organized into three separate chapters. The first chapter explores the stock price reactions of South Korean firms to geopolitical risk associated with inter-Korean relations. Using the method of keyword search proposed by Caldara and Iacoviello (2018), it presents a monthly measure of geopolitical risk concerning North Korea. Based on counts of news articles covering geopolitical tension, this measure continuously captures variations in region-specific geopolitical risk. In addition, both negative and positive factors of geopolitical swings are identified to reflect peace-seeking activities as well as tension-increasing ones. It further addresses

firm-level differential effects to figure out possible channels through which the geopolitical risk is transmitted. The regression results suggest that the stock returns of the firms that have a dominant share of domestic investors and large irreversible asset more sensitively respond to the risk in Inter-Korean relations. It is also found that geopolitical risks negatively affect firms that are involved in inter-Korean economic co-operations.

The second chapter examines the effects of economic sanctions on North Korea's trade. Using product-level trade data, I decompose the North Korea's trade with China into extensive margin, price and quantity, and subsequently estimate the impacts of the sanction on the two former factors. Along with recent trade literature, it uses product diversity and relative price as the proxy of trade quality (Hummels and Klenow, 2005). The results indicate quantity-driven growth and qualitative decline in North Korea's foreign trade. In particular, Japan's sanctions imposed in 2003 have a negative impact on the relative prices of North Korea's exports to China, implying that North Korea has disadvantages in bargaining power over China due to the sanctions by an important trading partner.

The final chapter investigates the role of Chinese firms in evading trade sanctions imposed on North Korea, especially focused on re-export of products imported from North Korea to other countries including South Korea. It estimates the effects of the sanctions by South Korea on the size of the re-export. This study extends the existing literature on North Korea's trade with China employing more detailed firm-product level analysis and using administrative database collected by Chinese Customs office. The results suggest the evidence on regional network through which North Korea's products were re-exported to South Korea with the role of Chinese firms as intermediaries. It is also found that the size of re-export substantially increased after the South Korean economic sanctions banning direct inter-Korean trade.

Chapter I. Geopolitical Risk from North Korea and Stock Market Reaction

1. Introduction

There has been increasing interest in the economic impact of geopolitical risk, following a series of events including ISIS terrorist attacks, North Korea's development of weapons of mass destruction (WMD), and so on. Recent empirical studies uncover that geopolitical risk affects asset pricing in financial markets (Berkman et al., 2011; Carney, 2016) and international capital flow (Caldara and Iacoviello, 2018). Furthermore, it is found that heightened geopolitical uncertainty induced by tension-increasing events has depressive macroeconomic effects (Ha, Lee and So, 2018).

At the regional level, North Korea is a one of the most important factor that determines geopolitical risk in South Korea. As of November 2019, North Korea has carried out 6 nuclear tests, half of which has been since 2012, when Kim Jong-Un came into power. North Korea also has launched missiles of various types and lengthened their range. After testing Hwasong-15 on Nov 29, 2017, which is theoretically capable of reaching all of the Unite States Mainland, concerns over North Korea's nuclear-capable missiles has been deepened. Despite of several times of Inter-Korean and US-NK summit, substantive agreement on North Korean nuclear issue has not been come out, and North Korea resumed testing missiles in 2019. In sum, there has been a serious geopolitical risk associated with Inter-Korean relations, and it fluctuates by a series of events escalating or easing tension.

Existing studies on the impact of North Korea's threat have mostly conducted event studies to make causal inference on the reaction of South Korean financial

market and found no significant impacts of North Korea-related events on the asset prices. These studies, however, are limited to a few events such as nuclear / missile test and military attack because it is difficult to set objective criteria for event selection. Moreover, the event study may fail to capture the fluctuations in geopolitical risk induced by the process around the events. (e.g. Summit meeting, attack on Cheonan battleship, Trump's tweeter, etc.).

In this consideration, this study proposes a novel measure of geopolitical risk associated with North Korea, reflecting the frequency of articles in leading Korean-read newspapers and broadcasts. It is based on the thought that the more economic agents consider the future uncertain about a particular issue, the more likely terms related to that issue will appear in the media. The methodology of this study is inspired by recent development of measuring various sources of uncertainty using media database such as Baker, Bloom and Davis (2016) and Caldara and Iacoviello (2018). In addition, we re-assess the effects of geopolitical tension surrounding Korean Peninsula on the financial market using this measure as the key identifier.

Consistent with earlier studies, our empirical results find almost no effects on the firms' stock returns on average. By contrast, we find that there are some differential uncertainty effects by firm characteristics. More specifically, increasing geopolitical uncertainty in Inter-Korean relations depresses stock returns for the firms that have large irreversible asset. experience of involvement in Inter-Korean economic cooperation. We also find that the firms with large share of foreign investors exhibits high stock return in the tension-increasing periods.

Our measurement and findings contribute to the literature in the following aspects. First, this study develops a media-based index of regional-specific geopolitical risk and estimate its impacts. Using a case of Korea with its historical and political uniqueness, we extend understanding of the investors' response to systemic uncertainty in the regional specific context. Second, we categorized the sources of geopolitical risk considering both tension-escalating and alleviating events. We also

present indices by topic and compare their effects to identify the important sources of geopolitical swings in affecting financial market. Third, we consider heterogeneity of firms in the response to geopolitical risk. The regression of this study is specified to estimate firm-level differential effects of the geopolitical risk by the size and composition of asset, ownership structure, and involvement in inter-Korean economic co-operation or production of defense goods.

2. Related Literature

This study is related to two strands of the literature. One is quantifying various sources of risk or uncertainty, and the other is estimating the effects of North Korean threat on South Korean economy.

2.1. News-based Uncertainty Index

Stimulated by the recent improvement of accessibility to media big-data, some researchers conducted pioneering studies on measuring uncertainty based on news frequency. Baker, Bloom and Davis (2016) measures economic policy uncertainty (EPU) of the United States based on monthly counts of articles contains (i) uncertainty or uncertain, (ii) economic or economy, and one of the policy-related keywords. Similarly, Caldara and Iacoviello (2018) presents a novel measure of global geopolitical risk (GPR) using automated text-searches of the 11 leading newspapers. The GPR index calculation is based on the frequency of articles containing keywords in the following six categories: *geopolitical threats, nuclear threats, war threats, terrorist threats, war acts, terrorist acts*. Both studies find adverse macroeconomic impacts of the uncertainty shocks. Furthermore, EPU affects firm-level economic activities such as stock price volatility, investment and employment decision and GPR induce capital outflow from developing countries. Our methodology of measuring

geopolitical risk from Inter-Korean relations mimics that of the two studies, but considers the regional-specific context.

2.2. The Effects of Geopolitical Risk from North Korea

There have been several attempts to estimate effects of North Korea's threat or aggression on South Korean economy, mostly on the stock market. For instance, Kim and Roland (2014) estimates cumulative abnormal return (CAR) of KOSPI index, Treasury yield and Won-Dollar exchange rate at the time of major geopolitical events caused by North Korea to find no significant impacts of the events on the financial markets. Kim and Jung (2014) addresses more broad set of events from 1999 to 2012 and find a negative response of the market return to North Korea's nuclear/missile tests and no significant response to the other kinds of geopolitical events such as military aggression. Gerlach and Yook (2016) investigates the investors' behavior surrounding 13 North Korean military provocations between 1999 and 2010, and finds that foreign investors increase their holdings of Korean stocks following the attacks and outperform that domestic individuals.

We depart from them by using continuous monthly measure to estimate more persistent effects of geopolitical tension, and highlighting differential effects by firm characteristics to avoid cancel-out of the effects and infer the possible channels through which the geopolitical risk induces changes in stock prices.

3. Measuring Geopolitical Risk from North Korea

3.1. Definition and Scope of Geopolitical Risk

The scope of geopolitical uncertainty considered in our paper is limited to the one affecting the Korean peninsula and, therefore, is closely linked to the unique historical

context of the region. Since the end of World War II, South and North Korea have been divided and exposed to frequent geopolitical flare-ups, such as military tensions and conflicts, but not without periods of détente when there were efforts of seeking reconciliation. The interplay of the world's great powers – the US, China, Japan, and Russia – on the Korean peninsula also has led to more complex and fluid inter-Korea relationship. Against this backdrop, we identify four major drivers that interact each other and form geopolitical landscape of the Korean peninsula: military conflicts/tensions, international sanctions on North Korea, bilateral and multilateral talks to seek a thaw in inter-Korea relations, and economic engagement between South and North Korea.

We highlight two features that distinguish our study from the existing papers. First, we consider both negative and positive drivers of geopolitical swings on the Korean peninsula to track changes in general perception of uncertainty. Earlier studies, for instance, Caldara and Iacoviello (2018), define geopolitical risks as the risks associated with different types of geopolitical events that affect peace in international relations, such as wars, terrorist acts, and tensions between nations. But we note that inter-Korea relationship has experienced both upside and downside risks repeatedly for a long period of time. There were times of escalating geopolitical tensions as well as peace-seeking periods, and recently the rotation of these two phases has become more frequent and unexpected. In order to capture such aspects of alternating geopolitical landscapes, we adopt a similar approach in Ha, Lee and So (2018) that includes both tension-increasing and peace-building geopolitical events in identifying geopolitical uncertainty. Yet we depart from their approach of using lists of geopolitical events to construct instrumental variables. Instead, we employ a text analysis to measure continuous changes in uncertainty by counting the number of news articles that contain the keywords identified by various drivers of geopolitical swings.

Second, we draw more attention to economic factors that may contribute to geopolitical swings. Military provocations or summit meetings are not purely political decisions after all. It is highly likely that foreign policies take economic objectives into serious considerations. Accordingly, we take note of economic incentives in geopolitics of inter-Korea relationship: international sanctions and prospects of economic cooperation. Such factors can significantly change geopolitical landscape by interacting with military and diplomatic strategies. Historically, tightening sanctions on commercial and financial transactions with North Korea in response to its nuclear and missile launches has led to more aggressive military actions of North Korea. Likewise, attempts to establish deeper economic cooperation with North Korea have helped ease geopolitical tensions by bringing related counterparties to the negotiation table.

3.2. Data and Methodology

The news articles to construct the geopolitical risk index come from BigKinds (https://www.bigkinds.or.kr), a news analysis service company established by Korea Press Foundation.[1] BigKinds provides analytics of South Korean news contents in Korean, covering approximately 60 million articles from 54 news media. The articles included in the database can be traced back to 1990 and is updated in real time. It allows users to search any keywords of interest within a specific time period, a selection of media and topics.

We select 16 newspapers and broadcasting companies that are representative of South Korean media. Among them, seven are national daily newspapers and six business and economics newspapers. The remaining three are national broadcast

[1] Korea Press Foundation is a South Korean public institution that promotes the quality of journalism and supports new technology in the news media. It is established in accordance with the Act on the Promotions of Newspapers.

companies.[2] The topics of news articles are limited to politics, economics, and international relations to avoid any undesirable noise. We search for the selected keywords from titles and/or contents of the news articles.

In selecting the search keywords, we go through five steps to capture continuous fluctuations in geopolitical uncertainty. First, we set "North Korea" as a default keyword to pick up the articles associated with the geopolitical risk from inter-Korea relationship.[3] Second, we categorize the topics into four to reflect the main drivers of inter-Korea relations with focus on potential economic impacts on South Korea: military tensions, sanctions, talks/agreements, economic cooperation. Third, we start by human readings of articles around the time of the major geopolitical events and list all the keywords by the subjects of the events (topic) and the descriptions of the subjects (action/status).[4] Forth, we list the words that collocate with the topic but negate the original aspects of the events. By doing so, we obtain the keywords to be excluded and avoid falsely selecting the articles that report the opposite. Last, we finalize the words by selecting the ones that recur and sufficiently cover the geopolitical events in the categories over time by iterations of validation process. See Table 1 top panel for search keywords translated in English and bottom panel for those in Korean.

[2] Nationwide newspapers (The total number of media, 7): Kyunghyang Shinmun, Kookmin Ilbo, Munhwa Ilbo, Seoul Shinmun, Segye Ilbo, Hankyoreh, Hankook Ilbo; Business and economics newspapers (6): Meail Business Newspaper, Money Today, Seoul Gyeongje, Financial News, Hankook Gyeongje, Herald Economy; National broadcasting companies (3): KBS, MBC, SBS.

[3] Note that South Korean newspapers tend to use Chinese characters (北, 北韓) to refer to North Korea.

[4] We refer to the geopolitical events provided by Arms Control Associations and Ministry of Unification.

Table Ⅰ-1. Search Keywords

Panel A : Translated (English)

Category		Topic	Action/Status	Excluded	Number of articles
Default keywords		North Korea			1,039,297
Negative	Military tensions	(nuclear) or (missile) or (military) or (war)	(threat) or (tension) or (provocation)	(Peace)	124,328
	Sanctions	(sanction) or (pressure)	(refute) or (dissent) or (criticize)		24,637
Positive	Talks/agreements	(talks) or (dialogue)	(resume) or (agreement) or (negotiation)	(fail) or (broke) or (boycott)	124,824
	Economic cooperation	(Economic cooperation) or (abbreviation of economic cooperation)	(progress) or (expectation)	(Concerns)	16,774

Panel B : Original (Korean)

Category		Topic	Action/Status	Excluded	Number of articles
Default keywords		North Korea			1,039,297
Negative	Military tensions	(핵) or (미사일) or (군사) or (전쟁)	(위협) or (긴장) or (도발)	(평화)	124,328
	Sanctions	(제재) or (압박)	(반발) or (불복) or (비난)		24,637
Positive	Talks/agreements	(대화) or (회담)	(재개) or (합의) or (협의)	(결렬) or (무산) or (거부)	124,824
	Economic cooperation	(경제협력) or (경협)	(추진) or (기대)	(우려)	16,774

Based on keyword searches, we compute the frequency of news articles by each category and each news outlet. Then we normalize the number of news articles using the total number of articles that include the term, “North Korea”. Next, we aggregate

the normalized number of articles across news media and divide it by the total number of media outlets. As such, we define the geopolitical risk by each category as follows:

$$U_{j,t} = \frac{1}{M}\sum_{i=1}^{M}\frac{N_{j,\,it}}{N_{it}}$$

where $U_{j,t}$ denotes risk from j category at time t. j denotes either one of four categories in search keywords: military threats, sanctions, talks, or economic cooperation. $N_{j,it}$ is total number of articles containing the keywords of each category j from media i at time t. N_{it} is total number of articles with default search keyword, North Korea, either in its title or content, for media i and time t. M is the total number of media outlet.

Next, we compute the upswings of geopolitical risk by summing the indices of positive events categories, talks and economic cooperation. Similarly, we aggregate the two indices of negative events categories, military tensions and sanctions, to quantify the downswings of geopolitical risk over time. We define the net negative risk as our benchmark geopolitical risk index, GPRNK, as follows:

$$\text{GPRNK}_t = U_{NEG,t} - U_{POS,t}$$

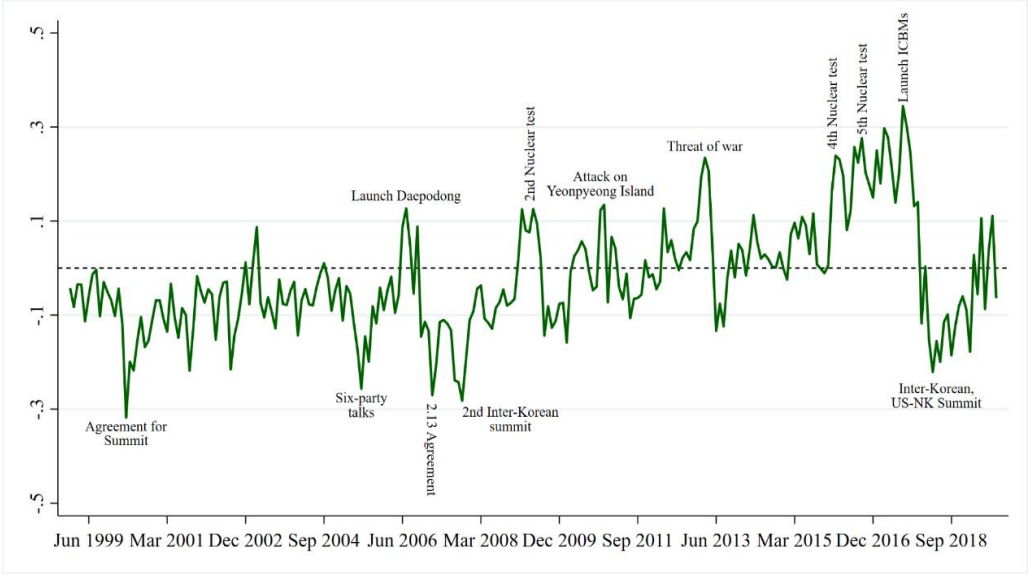
where GPRNK denotes the index of geopolitical risk from the inter-Korea relationships. $U_{NEG,t}$ denotes the geopolitical risk from tension-increasing events (military tensions and sanctions), $U_{Pos,t}$ from peace-building events (talks and economic cooperation).

3.3. Evaluating the GPRNK Index

Figure 1 plots the GPRNK index from January 1999 to December 2018. We annotate the key events that correspond to the spikes and the plunges of geopolitical risk index. The GPRNK index sharply increases in the occurrences of nuclear tests, missile

launches, and military confrontations, while decreases significantly at around the times of summit meetings and multilateral talks.

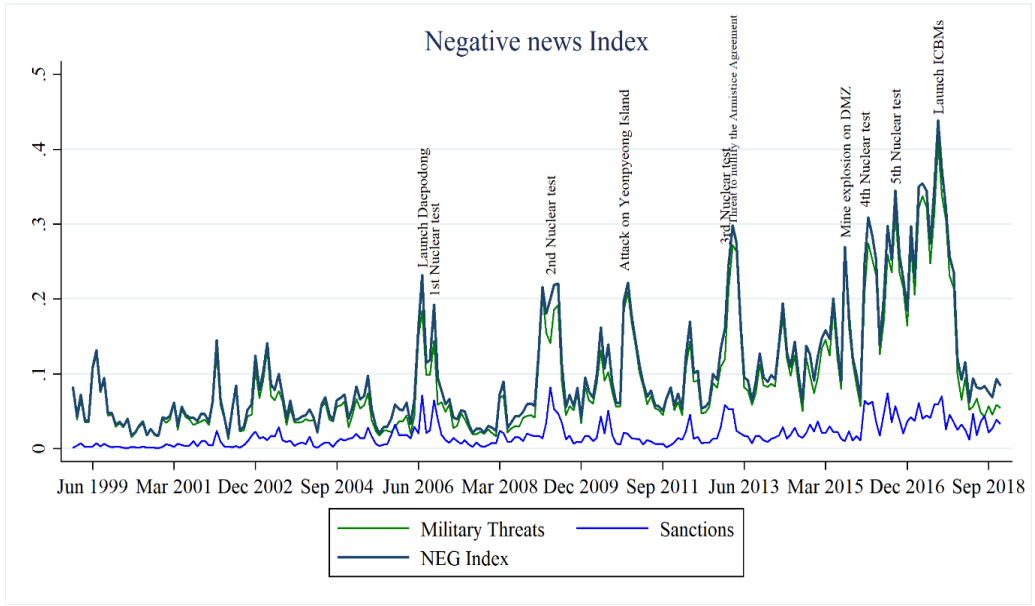
Figure I-1. The GPRNK Index

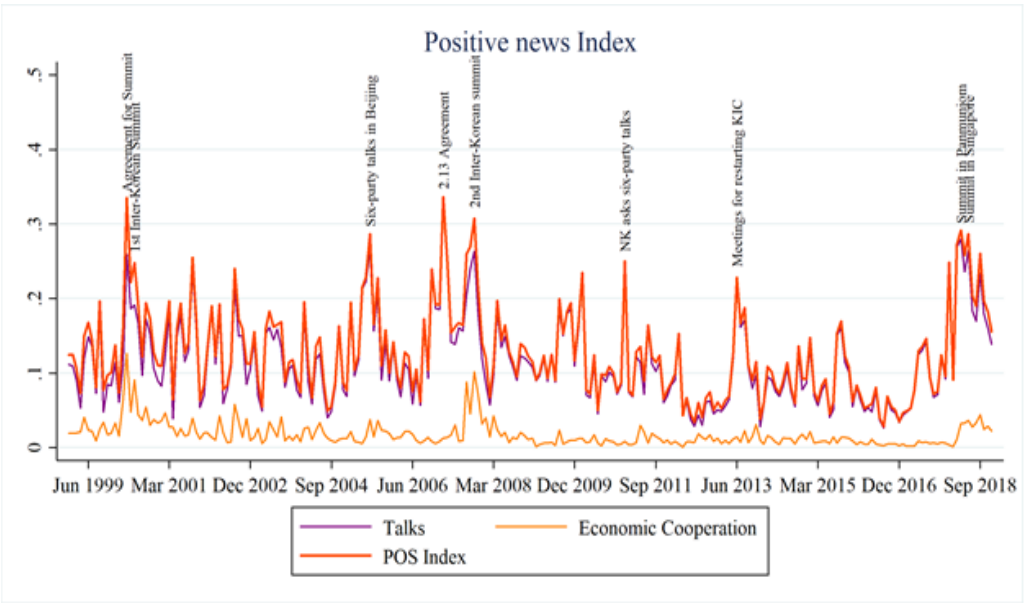


Notes: This figure plots the benchmark GPRNK index from January 1999 to December 2018.

As seen in Figure 2, the negative and positive indices are mostly dominated by military tension and talks category. Still, the indices of each category in the positive or negative domain are closely correlated. The correlation coefficient is about 0.71 between two indices in the negative domain, and 0.45 in the positive domain.

Figure I-2. News Index by Topic



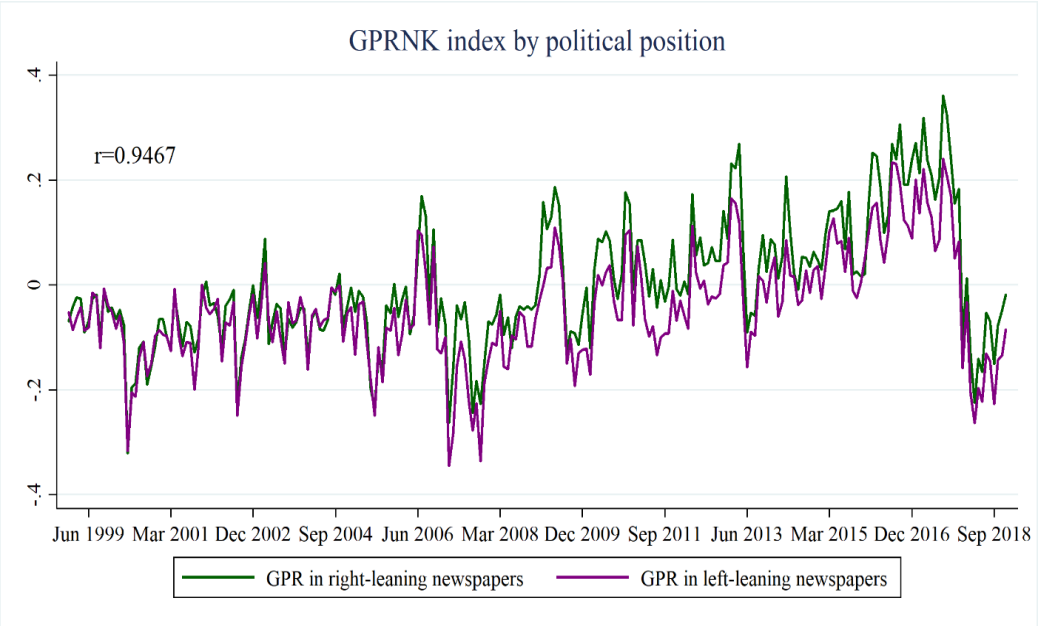


Our sample coverage for different media outlets may raise concerns about selection bias, especially because three most-read newspapers in South Korea are not included in the original data source. If one finds systemic differences in GPRNK

index by media characteristics, overall index produced by simple average of individual media may fail to represent the unbiased media attention on the North Korea-related issue in South Korea. In order to verify that the exclusion of these newspapers does not create significant selection bias, we calculate subgroup GPRNK indices by political leanings of news media (see Figure 3 top panel). The index computed from right-leaning newspapers and the one from left-leaning newspapers show close co-movement, with correlation coefficient of 0.947. We also find almost no systemic differences in geopolitical risk indices by media type. As seen in the bottom panel of Figure 3, the correlation coefficients of any pair of three types of news media – daily nationwide newspapers, business and economics newspapers, and national broadcasting companies – are above 0.94.

Figure 4 recalculates GPRNK index using alternative methods to combine news frequency by media and topic. The top panel displays a weighted average of the news frequencies by subscriber count or viewership to capture geopolitical risks perceived by news audiences. We set the media weight as the number of paid subscription and average viewership share in 2012 for newspaper and broadcast, respectively. The weighted GPRNK index shows almost perfect correlation with the benchmark index. The variations in our benchmark GPRNK index is dominated by those in military threat and talk category, thus the effects of sanctions and economic cooperation are likely to be undervalued. So, in the bottom panel, we standardize the news frequency of each category and media outlet to have mean zero, then average the standardized frequency to generate GPRNK index. The standardized GPRNK also exhibits very close co-movement with the benchmark index with a correlation coefficient 0.96.

Figure I-3. Possible Measurement Error from Media Selection



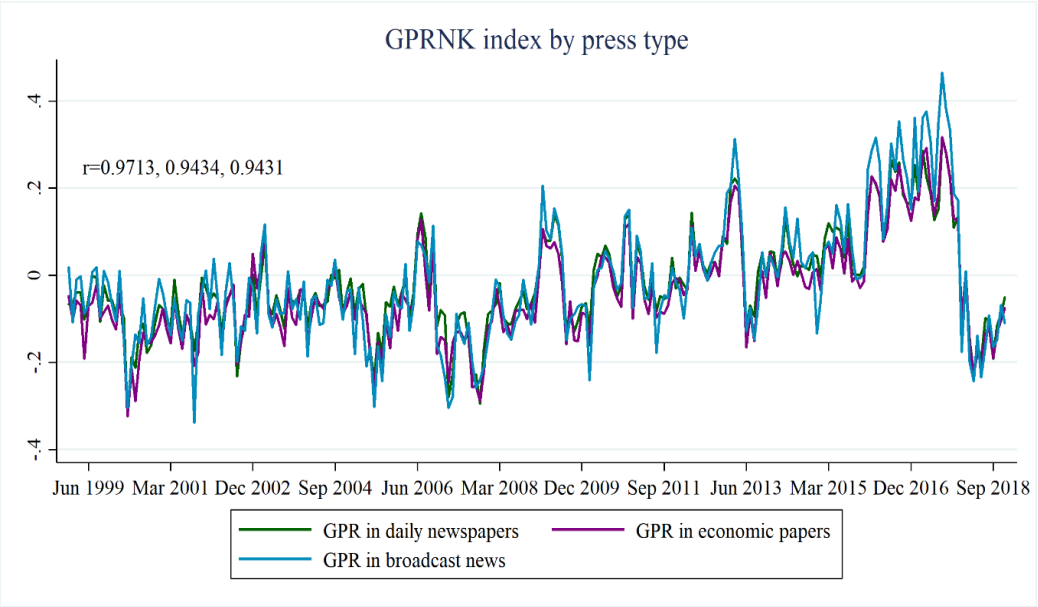
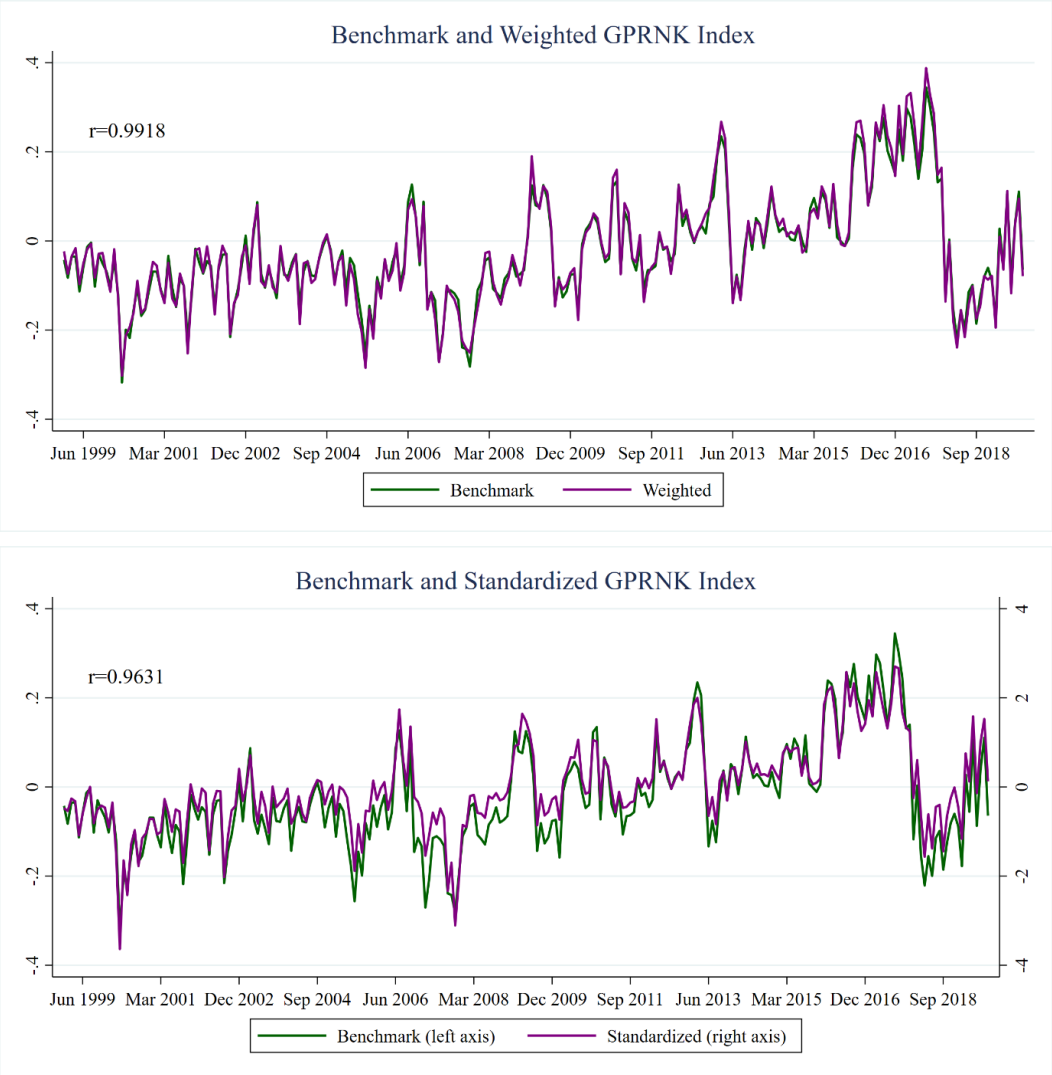


Figure I-4. Weighted and Standardized GPRNK Index

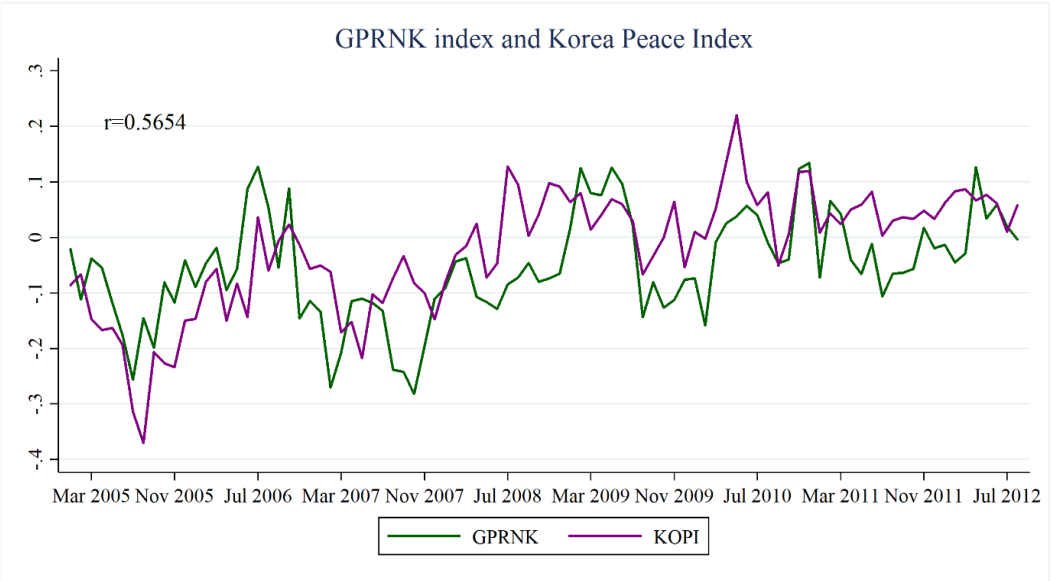


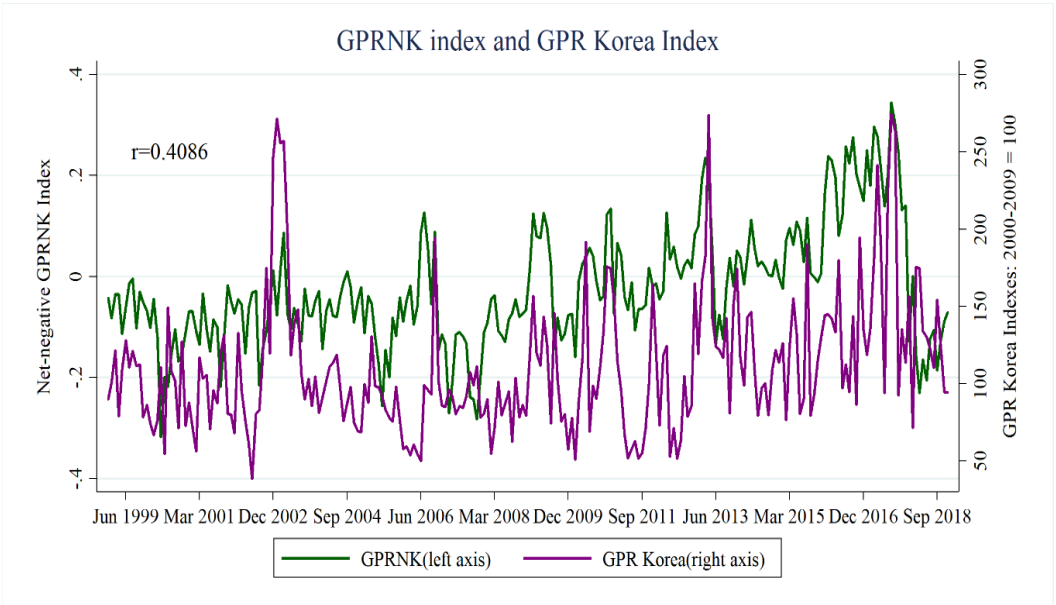
Next, we compare our GPRNK index with two other indices constructed using press coverage to quantify geopolitical risks from North Korea or inter-Korean conflicts. The top panel of Figure 5 shows the trend of Korea Peace Index (KOPI) suggested by Asia-Pacific Research Center of Hanyang University. Based on news articles released by Yeonhap News Agency, KOPI generates daily scores and monthly average index to capture fluctuations in inter-Korean relations from January 2005 to

September 2012. Like GPRNK index, it spikes at the time of threatening incidents such as Cheonan sinking or attack on Yeonpyeong Island, and plummets during 6-party talks or inter-Korean summit. However, KOPI underrates geopolitical tensions induced by North Korea's development of weapon of mass destruction because it is made based on qualitative rating for geopolitically meaningful events and regard the event of geopolitical acts more important than geopolitical threats. The correlation coefficient is about 0.57.

The bottom panel in Figure 5 compare GPRNK index with GPR Korea Index by Caldara and Iacoviello (2018). GPR Korea uses automated text-search to count the number of articles related with geopolitical risk in Korea. The search query of GPR Korea is a mixture of general keywords applicable to worldwide geopolitical risk. So it is suitable to measure broader geopolitical risks of global interests such as war threat, terrorism or cross-border tensions but may fail to capture Korea-specific context such as nuclear weapon development or bilateral talks. Furthermore, it assesses the geopolitical risks from a North-American and British perspective as the source of press coverage is restricted to 11 leading English-language newspapers published in the US, the UK and Canada. GPRNK index is based on Korean-language newspapers and may capture specific and detailed contexts of inter-Korea relations and the resulting fluctuations in geopolitical risk. The correlation with our GPRNK index is 0.41. This section evaluates internal and external validity of our measure. We first assess the potential measurement error from media coverage. We then discuss some contribution of GPRNK index by comparing it with existing measure of North Korean threat or geopolitical conflict around Korean Peninsula.

Figure I-5. Comparing GPRNK with Existing Measures





Source : KOPI - http://aprc.hanyang.ac.kr,
GPR Korea - https://www2.bc.edu/matteo-iacoviello/gpr.htm#description

4. Geopolitical Risk and Firm-level Stock Returns

In this section, we investigate whether geopolitical uncertainty affects stock returns by estimating firm-level panel regressions. In particular, we estimate the differential uncertainty effects by firm characteristics and shed light on the possible channels through which geopolitical uncertainty shocks are transmitted.

4.1. Empirical Framework

Our firm-level analysis focuses on examining the reaction of firms' stock returns to geopolitical swings induced by North Korean threat. Recent literature reports some empirical evidences unveiling the relationship between geopolitical risks and stock returns. Berkman, Jacobsen, and Lee (2011) find that changes in rare disaster risk has large negative effect on stock returns. Caldara and Iacoviello (2018) also report geopolitical risk depresses stock return significantly. However, their analysis is limited to average effects on world stock market or market returns of some advanced economies. Since stock price reaction to North Korean threat can be different across firm-specific conditions, coefficients in estimation that regress market return on risk index has potential to misleading by cancel-out stock-level effects. In particular, there are some South Korean companies that have been directly involved in economic cooperation with North Korea, which implies that the size of firm-level variations in effect of geopolitical risk is quite large.

4.1.1. Hypotheses

We propose three groups of hypotheses to identify firm-level sensitivity to North Korean issue. First hypotheses are established for equity ownership. South Korean stock market has a high level of foreign participation with foreign investment accounting for 33.6% of the total market capitalization in 2017, and the share of

foreign ownership varies substantially across firms.[5] [6] Literature of international portfolio investment suggests two contrasting views on the response of foreign investors to country-specific risk relative to that of domestic investors.. Home bias literature argues that information asymmetry leads foreign investors to be reluctant to hold asset with high-risk and perform worse than domestic investors (Kang and Stulz, 1997; Hau, 2001; Choe et al., 2005). On the other hand, foreign investors can have advantage of holding investment portfolio across market and be willing to hold risky assets to increase the benefit from international risk-diversification (Solnik, 1974; De santis and Gerard, 1997; Gerlach and Yook, 2016).

We hypothesize that if main driving factor making trading behavior different between foreign and domestic investor is information disadvantage, foreigners are likely to be net-seller in a period with high geopolitical risk, thus return of stocks with large fraction of foreigner stake show lower returns. On the other hand, if main driving factor is international diversification, foreigners have advantage to bear the risk from geopolitical conflict with North Korea, thus correlation between firm's stock return and foreigner ownership is higher when risk associated with North Korean threat is high.

The second hypothesis is about size and composition of firm's asset. In general case, high investor sentiment reduces stock returns of small and young stocks because capital moves to safety from such 'speculative' stocks (Baker and Wurgler, 2006; 2007). However, geopolitical conflict related to rare disaster risk may affect relation between asset size and stock returns in the other direction. Specifically, firms with large fraction of fixed asset could be more sensitive to geopolitical risk from North

[5] The foreign ownership can be decomposed into 37.2% in KOSPI market and 13.3% in KOSDAQ market. For details of information on foreign ownership in South Korean stock market, visit Korea Exchange homepage (http://marketdata.krx.co.kr/mdi#document=13020403).

[6] At the end of 2017, about half of 2,313 KRX-listed stocks have foreigner ownership of less than 2%, while 5% of them have more than 32% of foreigner ownership. Since foreigner ownership is positively correlated with size of market capital, foreign investment tends to be concentrated on the small number of big companies in South Korea.

Korea with expectation of great damage from possible rare disaster such as war. We hypothesize that if investors update their belief on rare disaster risk recognizing media reports on North Korea, stock return is decreasing with firm's asset size and fraction of fixed asset when the geopolitical tension is intensified.

The last hypotheses identify firm-level sensitivity to risk from North Korea more directly by setting firms involved in Inter-Korean economic cooperation or defense industry as treatment group. Inter-Korean economic cooperation, fist allowed after 7.7 statements in 1988, has been continuously grown up in size and expanded across sectors such as tourism, fabric processing or infra construction. Many South Korean firms had participated in cooperation with North Korea including KIC, before it was indefinitely stopped in the aftermath the fourth nuclear test.[7] As Inter-Korean tensions tighten or loosen, investors may expect these business to flourish or decay. This leads to the hypothesis that increasing GPRNK index would reduce the stock return of firms involved in economic cooperation. We also hypothesize that if investors expect South Korean defense industry to expand in response to increasing geopolitical tension, stock return of related firm may decrease.

4.1.2. Estimation model

We propose following equation to test the hypotheses discussed above :

$$return_{it} = \alpha_i + GPRNK_t * X_i'\beta + C_{it}'\gamma + \delta_t + \varepsilon_{it}, \quad (1)$$

Where $return_{it}$ is monthly stock return of firm i at time t, $GPRNK_t$ is our geopolitical risk index, X_i is a vector for firm's characteristic selected to identify sensitivity to geopolitical risk, and C_{it} is a set of control variables. For the time-varying firm-level sensitivity measure, i.e. foreigner ownership, size of asset and proportion of fixed asset to total asset, we calculate firm-level mean over sample

[7] The appendix table A.xx presents the list of stocks related to economic cooperation with North Korea. We collected this list from previous literature (Kim and Jung, 2014) and those used in Korea Investment Securities Co.

period to avoid reverse causality problem and remove noise from high-frequency variations.[8] C_{it} is selected with reference to previous literature on cross-section of stock returns including market capitalization (Banz, 1981; Fama and French, 1992), leverage ratio(Bhandari, 1988), book-to-market ratio (Fama and French, 1992, 1993; Petkova and Zhang, 2005), Profitability (Basu, 1983; Haugen and Baker, 1996), and firm beta (Fama and French, 1992; Jagannathan and Wang, 1998).

4.2. Data and Descriptive Statistics

Our empirical analysis is based on the information about 2,582 South Korean non-financial companies from 2006 to 2018. We use monthly stock market data from DataGuide provided by Fnguide and quarterly accounts data from KIS Value provided by National Information & Credit Evaluation Inc.(NICE). The variables used in regression model are described in Table 2.

The sample period is set to start from 2006 because there are a lot of missing values in key explanatory variables and GPRNK index does not fluctuate greatly before then. The original sample covers every firms once listed on the Korea Exchange(KRX) during the sample period. To reduce the possibility that regression result is driven by small number of extreme observations, we restrict the sample according to the following criteria. First, we only include firms observed in 10% of sample period at least. Second, we drop out firms that experienced impairment of whole equity. Third, we also eliminate observations that record negative sales or operation loss exceeds total asset. In result, the final sample includes 2,529 firms.

[8] Our specification for sensitivity measure mimics that of Baker, Bloom and Davis (2016), which uses revenue-weighted industry-level government purchase ratio averaged across time periods as proxy of firm-level exposure to government policy uncertainty. We also present the estimation results from alternative specification using time-varying firm characteristics in Appendix table 3.

Table I-2. Variable Description

Variable	Description	Source
Stock return	Log difference in last day's revised stock price between period t and period t-1	DataGuide
Market Capitalization	Log of market capitalization at the end of last month.	DataGuide
Book-to-Market	The ratio of asset size to market capitalization at the end of last month.	DataGuide, KisValue
Foreigner ownership	The proportion of foreigner's stake in market capital.	DataGuide
Beta	The coefficient that regress firm's daily stock return on market return in previous 300 trading days.	DataGuide
Asset size	Log of total value of asset at the end of last quarter.	KisValue
ROA	The ratio of operating profit to total asset value	KisValue
Fixed-to-Total	The ratio of fixed capital to total asset value	KisValue
Leverage ratio	The ratio of total debt to market capitalization	KisValue
Economic Cooperation	Dummy variable indicating involvement in economic cooperation	Kim and Jung(2014)
Defense	Dummy variable indicating business related to defense industry	Kim and Jung(2014)

Table 3 presents summary statistics of variables and compares their mean values of high-GPRNK periods with low-GPRNK periods. The sample stock's average monthly return is -0.5 percent over whole sample periods, which turns into -1.2% when GPRNK index is negative and 0.2% when the index is positive. However, this doesn't necessarily mean that geopolitical tension with North Korea moves up average stock return. Due to the high dependency on export of South Korean economy, stock returns are mainly affected by external economic conditions and especially show close co-movement with US stock market return. So we discuss the average effect of geopolitical risk on stock return in the next section with some control variables.

Table Ⅰ-3. Summary Statistics for Firm-level Variables

						GPRNK <0		GPRNK >= 0	
	Mean	SD	Min	Max	Obs	Mean	SD	Mean	SD
Stock return	-0.005	0.177	-4.758	3.912	268,107	-0.012	0.185	0.002	0.169
Liquidity	0.015	0.037	0.000	1.626	264,947	0.014	0.035	0.016	0.038
Volatility	0.030	0.019	0.000	1.253	259,481	0.033	0.020	0.029	0.018
Market Capitalization	25.282	1.464	18.031	33.507	267,613	25.194	1.460	25.362	1.464
Book-to-Market	1.066	0.835	0.001	19.593	254,763	1.087	0.854	1.046	0.817
Foreigner ownership	0.074	0.123	0.000	0.993	238,385	0.077	0.126	0.072	0.120
Beta	0.826	0.422	-3.769	6.412	258,907	0.816	0.409	0.836	0.434
Asset size	25.726	1.417	21.591	33.020	252,520	25.649	1.418	25.796	1.412
ROA	0.011	0.048	-2.747	1.448	252,505	0.011	0.049	0.010	0.042
Fixed-to-total	0.531	0.195	0.000	1.000	251,829	0.524	0.194	0.537	0.196

Notes
1. Liquidity : trade volume / market value
2. Volatility : standard deviation of daily stock return within last 20-days.

We examine whether there are systemic differences by firm characteristics in effect of GPR measure on stock return by estimating naïve difference-in-difference coefficients. The first three rows of Table 4 report that average stock-return gap between big company and small-medium company is about 1.8% and 0.6%, in periods with high and low geopolitical risk index, respectively. The difference in difference coefficients is 1.16% and statistically significant, suggesting that big company get relatively more negative impacts by geopolitical tension with NK. Next three rows present differences in average stock return by foreigner ownership and GPRNK index. The stock return gap also smaller in periods with high-GPRNK than those with low-GPRNK, but the difference-in-difference coefficient isn't significant this time. The rest of rows suggest that firms with high proportion of fixed asset or involved in Inter-Korean economic cooperation are more vulnerable to geopolitical risk from North Korea, presenting significant difference-in-difference coefficients.

Table Ⅰ-4. Stock Return by GPRNK Index and Possible Sensitivity Measure

		GPRNK <0			GPRNK >= 0			
		Mean	SE	Obs	Mean	SE	Obs	D in D
Size	Small-Medium	-0.0212	0.0009	60,584	-0.0013	0.0008	66,328	
	Large	-0.0034	0.0006	67,789	0.0050	0.0005	73,406	-0.0116
	Difference	0.0178	0.0010	128,373	0.0062	0.0009	139,734	[0.0014]***
Foreigner Ownership	Low	-0.0151	0.0008	58,957	-0.0008	0.0007	66,231	
	High	-0.0087	0.0007	54,088	0.0043	0.0006	58,964	-0.0013
	Difference	0.0064	0.0011	113,045	0.0051	0.0009	125,195	[0.0014]
Fraction of Fixed Asset	Low	-0.0126	0.0007	68,478	0.0024	0.0007	73,897	
	High	-0.0108	0.0007	59,895	0.0015	0.0006	65,837	-0.0027
	Difference	0.0018	0.0010	128,373	-0.0009	0.0009	139,734	[0.0014]**
Economic Cooperation	Non-Involved	-0.0127	0.0005	122,213	0.0022	0.0005	133,107	
	Involved	0.0058	0.0022	6,156	-0.0027	0.0016	6,627	-0.0234
	Difference	0.0185	0.0024	128,373	-0.0049	0.0021	139,734	[0.0032]***

Notes : Sample firms are classified by following criteria.
1. Size - Large, for a firm with more than 500 employment, small-medium, otherwise.
2. Foreigner ownership - High, for a firm with more than 3% of foreigner stake, low, otherwise.
3. Fraction of Fixed Asset - High, for a firm with fixed-to-total ratio over median value, low, otherwise.

4.3. Baseline Results

In this section, we show the baseline results from the regression model discussed above. Column (1) of Table 5 displays coefficient from regressing firm-level stock return on GPRNK index with the control of monthly return in Dow Index and Won-Dollar exchange rate, global financial crisis dummy and firm fixed effect. The coefficient of GPRNK suggests that there is almost no average effect of geopolitical risk on stock returns.

Table Ⅰ-5. Geopolitical Risk from North Korea and Firm-level Stock Return in South Korea.

Dependent Variable : Monthly Stock Return	(1)	(2)	(3)	(4)	(5)	(6)
GPRNK Index	0.0000					
	(0.0003)					
GPRNK * Foreigner ownership		0.0005***			0.0012***	0.0015***
		(0.0002)			(0.0002)	(0.0003)
GPRNK * log(asset)			-0.0005**		-0.0010***	-0.0022***
			(0.0002)		(0.0002)	(0.0003)
GPRNK * (Fixed asset/Total asset)			-0.0035**		-0.0033**	-0.0027
			(0.0017)		(0.0017)	(0.0018)
GPRNK * Ecoop dummy				-0.0076***	-0.0071***	-0.0089***
				(0.0012)	(0.0012)	(0.0014)
GPRNK * Defense dummy				-0.0007	-0.0001	-0.0035**
				(0.0013)	(0.0012)	(0.0016)
Book-to-Market						0.0120***
						(0.0016)
Leverage ratio						0.0033
						(0.0049)
ROA						0.2921***
						(0.0174)
Time-varing common controls	Yes	No	No	No	No	No
Time-varing firm-level controls	No	No	No	No	No	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effects	No	Yes	Yes	Yes	Yes	Yes
Number of Observations	268,107	260,687	260,644	268,107	259,028	243,783
Number of firms	2,529	2,323	2,337	2,529	2,298	2,269
Adjusted R2	0.0406	0.1337	0.1327	0.1234	0.1341	0.1636

Notes : The dependent variable is monthly stock return calculatied based on log differntiation. The figures in the table are fixed effect OLS coefficients and the figures in the parentheses are robust standard erros clustered at the firm level. *, **, *** indicates statistical significance at the 10%, 5%, 1% level, respectively. The coefficients on GPRNK and its interactions represent the effects of 1-standard deviation increase of GPRNK index. We control monthly return in Dow Index and Won-Dollar exchange rate and global financial crisis dummy for column (1), total market value at t-1, book-to-market ratio at t-1, leverage ratio, ROA and firm beta for column (6). The sample covers 2006m1~2018m12

Column (2)~(4) contains results from testing three key hypotheses respectively. Now, we add time fixed effects to control unobserved factors that commonly affect stock returns for each period, thus drop out the control variables which can be spanned by time dummies. Column (2) investigate the differential effects of the GPRNK by

the share of foreigner's stake. We find evidence that firms with large share of foreigner's investment have relatively higher stock return in periods with escalating geopolitical tension. The coefficient of the interaction term implies that one standard deviation increase in our GPRNK index would make 0.15% points increase in stock return of a firm with 40% of foreigner's stake relative to a firm with 2% of foreigner's stake. This is in line with the international diversification hypothesis.[9]

Column (3) shows the results from regressing stock return on interactions of GPRNK index with asset size and share of fixed asset. The coefficients are significantly negative for both interaction terms, suggesting that geopolitical risk from North Korea has more negative effects on firms with large asset size and high proportion of fixed asset. We find that 10% increase of GPRNK index is associated with 0.05% less monthly stock return of a firm with two times bigger in asset size, and 0.04% less return of a firm with 10% points greater share of fixed asset.

In column (4), we estimate the difference in effect of GPRNK on stock return by involvement in economic cooperation with North Korea or production of defense goods. As expected, GPRNK negatively affects stock return of firms involved in economic cooperation, with sizable coefficients implying that 1-standard deviation increase of the index reduce the stock returns of North Korea -engaged firms by 0.76% points relative to those of non-involved firm. On the other hand, firms in defense industry does not show any specialty in stock return by fluctuation in geopolitical risk.

We next pool all of the three hypotheses in one regression in column (5). All of the estimates are same with previous columns in sign and statistical significance, but the coefficients of GPRNK interaction with foreigner ownership and total asset become about two times bigger in absolute value. The results imply that 1-standard

[9] Foreigner's investment in the South Korean stock market have shown modestly rising trend overall. The most prominent exception is the global financial crisis, when the foreigners' stake over total market capitalization fall 6% points from 2008 to early 2009. This supports our explanation that foreigners trading behavior does not sensitively react to country-specific risk factor because of benefit from holding internationally diversified portfolio.

deviation increase in GPRNK index is associated with increase in stock return by 0.10% points as total asset get two times bigger and increase in difference in stock return between firms with foreigner's share of 40% and 2% by 0.36% points.

Column (6) examines whether inclusion of other determinants of firm-level stock return change the regression results. We control book-to-market ratio, ROA, total market capitalization, firm beta and leverage ratio. Considering these covariates together, the GPRNK interactions with every firm-level sensitivity measure keep showing the same sign and increase in absolute value except for fixed-to-total asset ratio. The estimate fixed-to-total asset ratio now become small and statistically insignificant.

Table 6 displays regression results from using various type of indices. In column (1), we use the index based on the threat-increasing news only. Coefficients of interactions are estimated to be similar with regression results using net-negative GPRNK index, but interaction with share of fixed asset become smaller and statistically insignificant. Column (2) contains the regression result from use of the positive news index. Every interaction terms show opposite sign with regression results from using the net-negative index and statistical significance, implying that news on relief and escalation of tension affect firms' stock returns in opposite direction. This results support the plausibility of our construction of GPRNK index using both of negative and positive tone news on geopolitical issue associated with NK.

Table Ⅰ- 6. Geopolitical Risk from North Korea and Firm-level Stock Return in South Korea: Various Indices

Dependent Variable : Monthly stock return	Negative-only (1)	Positive-only (2)	Military threat (3)	Sanctions (4)	Talks (5)	Economic Cooperation (6)	NK-to-All (7)	Net-negative in English (8)	GPR Korea (9)
GPRNK * Foreigner ownership	0.0010***	-0.0016***	0.0010***	0.0003	-0.0015***	-0.0008**	0.0003	0.0012***	0.0007***
	(0.0003)	(0.0003)	(0.0002)	(0.0003)	(0.0003)	(0.0004)	(0.0002)	(0.0003)	(0.0003)
GPRNK * log(asset)	-0.0026***	0.0009***	-0.0023***	-0.0030***	0.0007**	0.0022***	-0.0009***	-0.0036***	-0.0015***
	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0004)	(0.0003)	(0.0004)	(0.0003)
GPRNK * (Fixed asset/Total asset)	-0.0009	0.0042**	-0.0008	-0.0017	0.0040**	0.0045*	0.0031*	-0.0015	0.0008
	(0.0017)	(0.0020)	(0.0016)	(0.0020)	(0.0020)	(0.0026)	(0.0017)	(0.0022)	(0.0019)
GPRNK * Ecoop dummy	-0.0054***	0.0106***	-0.0054***	-0.0031**	0.0102***	0.0088***	0.0035***	-0.0052***	0.0016
	(0.0011)	(0.0016)	(0.0011)	(0.0013)	(0.0015)	(0.0023)	(0.0010)	(0.0016)	(0.0011)
GPRNK * Defense dummy	-0.0028*	0.0031*	-0.0028*	-0.0008	0.0031*	0.0009	-0.0001	-0.0026	0.0000
	(0.0015)	(0.0017)	(0.0015)	(0.0017)	(0.0017)	(0.0019)	(0.0013)	(0.0019)	(0.0019)
Number of Observations	2.44E+05	2.44E+05	2.44E+05	2.44E+05	2.44E+05	2.44E+05	2.44E+05	2.10E+05	2.44E+05
Number of firms	2269	2269	2269	2269	2269	2269	2269	2255	2269
Adjusted R2	0.1636	0.1634	0.1635	0.1637	0.1634	0.1634	0.1631	0.1669	0.1631
Time-varing firm-level controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm and time fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes : The figures in the table are fixed effect OLS coefficients and the figures in the parentheses are robust standard erros clustered at the firm level. *, **, *** indicates statistical significance at the 10%, 5%, 1% level, respectively. Every estimates represents the effect of 1-standard deviation increase of GPRNK index.
All column include firm and time fixed effects and firm-level control variables. The sample covers 2006m1 ~ 2018m12 except for column (8) that covers 2007m1~2017m12.

Column (3)~(6) in Table 6 use the indices based on keywords search in the four categories, separately. We find that firms with large foreigner's share exhibit relatively high return in reaction to news on military threat, and relatively low return in reaction to news on dialogue or economic cooperation with North Korea. Effects by firm's asset size are estimated to be significantly negative for the two category-specific measures on 'bad news' and positive for the other two measures on 'good news'. Interaction terms with fixed-to-total ratio are only significant for two 'good news' indices. We also find that stock return of firms involved in economic cooperation show sensitive reaction to all of four category-specific measure of GPR. In particular, the coefficient is large and highly significant on the economic cooperation index, which suggest that expectations for the business opportunity with North Korea is largely reflected in the stock price of involved companies. Overall, the estimates on interactions with category-specific measures are consistent with the results of table 5.

In column (7)~(9), we compare the main results with those from alternative source or specification of measures. Column (7) replaces our GPRNK index with a simple measure calculated by the relative frequency of NK-related article to total article. This specification considers media coverage on NK as risk-increasing factor in South Korean stock market, regardless of the contents of articles.[10] However, the results are confounding because the direction of effects of increasing media coverage on NK depends on the main issue of the time. The positive coefficients on the economic cooperation enhance this concern and support the importance of contents of news in measuring geopolitical risk from media coverage. Column (8) employs the media sources of English-language newspapers. We translated the keywords in English and

[10] Kim et al. (2019) used this type of measure to estimate the effect of geopolitical risk on trading behavior in South Korean market. However, the sample period of this study is limited to 2015~2017, when tension-escalating events dominate media coverage on North Korea. If the sample period is expanded, one may find the opposite results under the same framework.

search the frequency of articles from Bloomberg database. The estimates are essentially not different with the main results from GPRNK measure by Korean-language media. Finally, in column (9) we use the GPR Korea index by Caldara and Iacoviello (2018). The coefficients on foreigner ownership and asset size are similar with those of our GPRNK measure, but those on fixed-to-total ratio and involvement in economic cooperation are not significant. The insignificant coefficient on economic cooperation dummy suggest that GPR Korea index does not capture North Korea specific risk factors well.

4.4. Robustness Check

In this section, we check robustness of our estimation with a wide range of additional settings. First, Table 7 presents the result from more restricted sample firms. In column (1) and (2), we consider the possibility that firms' entry and exit affect the stock return and have systemic correlation with sensitivity to external shocks. So we exclude observations from firms that have been delisted as of 2018 in column (1), and further exclude firms listed on KRX later than 2006 in column (2). Sample is limited to manufacturing firms in column (3), because stock return volatility of service companies is likely greater than that of manufacturing companies and the main results might be driven by the extremeness of the formers. We find our main results are robust under these restrictions for sample firms.

Column (4) ~ (5) of Table 7 consider the fact that foreign investment is concentrated in a small number of large companies and most of the items has very low foreigner's share, thus the baseline results may be driven by variations between firms with low-level of foreigner ownership. To estimate the effects of GPRNK on the stocks with nontrivial foreigner ownership, we restrict sample to top-200 firms in market value and top-100 firms in foreign investment in column (4) and (5),

respectively. The coefficients on GPRNK interactions with foreigner's share still positive and statistically significant.

Table Ⅰ-7. Robustness 1 : Results from Narrowed Sample Firms

	Exclude delisted (1)	All-time observed (2)	Manufacturing firms (3)	Top-200 in Market Value (4)	Top-100 in Foreigner Investment (5)
GPRNK * Foreigner ownership	0.0012***	0.0011***	0.0014***	0.0022**	0.0060***
	(0.0003)	(0.0003)	(0.0003)	(0.0009)	(0.0020)
GPRNK * log(asset)	-0.0020***	-0.0023***	-0.0020***	-0.0016**	-0.0003
	(0.0003)	(0.0003)	(0.0004)	(0.0008)	(0.0008)
GPRNK * (Fixed asset/Total asset)	-0.0036**	-0.0038*	-0.0032	0.0057	0.0043
	(0.0017)	(0.0020)	(0.0026)	(0.0044)	(0.0054)
GPRNK * Ecoop dummy	-0.0094***	-0.0099***	-0.0083***	-0.0052*	-0.0033
	(0.0014)	(0.0016)	(0.0017)	(0.0027)	(0.0032)
GPRNK * Defense dummy	-0.0038**	-0.0041**	-0.0040**	-0.0030	-0.0025
	(0.0016)	(0.0018)	(0.0020)	(0.0024)	(0.0028)
Number of Observations	219,776	164,326	159,419	26,746	14,950
Number of firms	1,858	1,097	1,484	383	199
Adjusted R2	0.1789	0.1845	0.1747	0.2562	0.2644
Time-varing firm-level controls	Yes	Yes	Yes	Yes	Yes
Firm and time fixed effects	Yes	Yes	Yes	Yes	Yes

Notes : The figures in the table are fixed effect OLS coefficients and the figures in the parentheses are robust standard erros clustered at the firm level. *, **, *** indicates statistical significance at the 10%, 5%, 1% level, respectively. The dependent variable is monthly stock return. Every estimates represents the effect of 1-standard deviation increase of GPRNK index. We exclude items that have been delisted as of Dec. 2018 in column (1). We also exclude firms listed after 2006, i.e. only include those observed all over the sample period, in column (2). The sample is restricted to manufacturing company, top-200 firm in market value, and top-100 in foreigner's investments in column (3), (4) and (5), respectively.

Table 8 attempts to further control the time-specific effect which can be interact with firm characteristics of interest. Column (1) and (2) consider the seasonality of stock return, the well-known year-end and new-year effect. We remove December observations and January observations of each year in column (1) and column (2), respectively. Also, the distribution of firm-level stock return can be changed by overall stock market movement. In column (3) and (4), we separate the whole sample into the periods of positive market return and negative market return. The estimates keep the sign and statistical significance consistent with the main results. Column (5) and (6) check whether the main results changes by the transitions in news platform.

In Korea, portal sites such as Naver and Daum are acting as a major news platform on the net, and their influence has expanded with the wide use of smartphones. So, we separate the sample period into before and after 2012, when the number of smartphone users first exceeds 50% of the population.[11]

In column (7) and (8), we separate the sample period into before and after 2016. The geopolitical conflict around Korean Peninsula has received grater international attention recently, because of the drastic improvement in the destructive power and delivery capability of North Korea's nuclear weapons. So, we test whether the market's response to GPRNK has changed since 2016. The coefficients of interactions between GPR measure with foreigner ownership become smaller after 2016, which suggests that the foreign investors' advantage of international diversification in response to escalating geopolitical tension have diminished recently. Tests for hypotheses on size and composition of asset show conflicting results. The GPRNK interaction term with asset size is estimated as opposite sign in the period after 2016, but interaction with share of fixed asset become larger in absolute value and statistically significant. The stock return of firms involved in economic cooperation with North Korea are negatively affected by geopolitical risk from North Korea regardless of sample periods separation.

[11] http://www.gallup.co.kr/gallupdb/reportContent.asp?seqNo=943

Table Ⅰ- 8. Robustness 2 : Results from Narrowed Sample Periods

	Exclude Jan	Exclude Dec	Market Return>0	Market Return<0	Year < 2012	Year>=2012	Year < 2016	Year>=2016
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
GPRNK * Foreigner ownership	0.0013***	0.0014***	0.0016***	0.0014***	0.0016***	0.0010***	0.0025***	0.0012***
	(0.0003)	(0.0003)	(0.0003)	(0.0004)	(0.0006)	(0.0003)	(0.0004)	(0.0004)
GPRNK * log(asset)	-0.0026***	-0.0023***	-0.0021***	-0.0026***	-0.0013**	-0.0004	-0.0039***	0.0015***
	(0.0003)	(0.0003)	(0.0004)	(0.0004)	(0.0006)	(0.0003)	(0.0005)	(0.0004)
GPRNK * (Fixed asset/Total asset)	-0.0025	-0.0029	-0.0016	-0.0048	0.0016	-0.0046**	-0.0024	-0.0057**
	(0.0019)	(0.0018)	(0.0023)	(0.0030)	(0.0042)	(0.0020)	(0.0033)	(0.0029)
GPRNK * Ecoop dummy	-0.0087***	-0.0093***	-0.0095***	-0.0090***	-0.0123***	-0.0103***	-0.0112***	-0.0153***
	(0.0015)	(0.0015)	(0.0018)	(0.0021)	(0.0029)	(0.0017)	(0.0025)	(0.0025)
GPRNK * Defense dummy	-0.0034**	-0.0031*	-0.0022	-0.0066***	0.0004	-0.0008	-0.0067***	0.0022
	(0.0016)	(0.0017)	(0.0021)	(0.0023)	(0.0033)	(0.0021)	(0.0026)	(0.0025)
Number of Observations	224,891	224,139	137,529	106,254	106,171	137,612	182,618	61,165
Number of firms	2,269	2,269	2,268	2,268	1,853	2,004	2,094	1,905
Adjusted R2	0.1644	0.1701	0.1027	0.1659	0.2115	0.12	0.1739	0.1508
Time-varing firm-level controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm and time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes : The figures in the table are fixed effect OLS coefficients and the figures in the parentheses are robust standard erros clustered at the firm level. *, **, *** indicates statistical significance at the 10%, 5%, 1% level, respectively. The dependent variable is monthly stock return. Every estimates represents the effect of 1-standard deviation increase of GPRNK index.

We exclude sample of which calender month is December and January in column (1) and (2), respectively. Column (3) and (4) seperate sample into periods with positive and negative market return. Column (5)~(6) and (7)~(8) seperate sample periods before and after 2012 and 2016, respectively.

The use of simple monthly index may cause bias on the timing of the effects. For example, if the index is mainly driven by the events that occurs at the early timing of each month, the estimates can be interpreted as monthly cumulative effects. On the other hand, the index driven by the events at the end of each month may affect stock price of following month. So we calculate the 3-month moving averaged index to expand the window of effect so that reduce these timing biases. Table 9 present the estimates from using moving-averaged indices. Column (1) and (2) apply window from t-1 to t+1, with equal weight in column (1) and double weight on t in column (2), while column (3) and (4) use window from t-2 to t. Column (5) and (6) replace the GPRNK index with weighted index and standardized index discussed in the section 3.3. These alternative settings of GPRNK index all yield similar results with column (6) of Table 5.

Table Ⅰ-9. Robustness 3 : Alternative Index Calculation

	Moving-averaged index with window : [t-1, t+1]		Moving-averaged Index with window : [t-2, t]		Subscription-weighted index	Standardized index
	Equal weight	Double weight on t	Equal weight	Double weight on t		
GPRNK * Foreigner ownership	0.0014***	0.0012***	0.0014***	0.0013***	0.0015***	0.0013***
	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)
GPRNK * log(asset)	-0.0022***	-0.0024***	-0.0022***	-0.0024***	-0.0020***	-0.0027***
	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)
GPRNK * (Fixed asset/Total asset)	-0.0028	-0.0010	-0.0028	-0.0015	-0.0022	-0.0032
	(0.0018)	(0.0018)	(0.0018)	(0.0018)	(0.0017)	(0.0020)
GPRNK * Ecoop dummy	-0.0092***	-0.0071***	-0.0092***	-0.0077***	-0.0088***	-0.0091***
	(0.0015)	(0.0014)	(0.0015)	(0.0014)	(0.0014)	(0.0016)
GPRNK * Defense dummy	-0.0043***	-0.0056***	-0.0041**	-0.0052***	-0.0035**	-0.0028*
	(0.0016)	(0.0017)	(0.0016)	(0.0017)	(0.0017)	(0.0017)
Number of Observations	243,783	243,783	243,783	243,783	243,783	243,783
Number of firms	2,269	2,269	2,269	2,269	2,269	2,269
Adjusted R2	0.1637	0.1636	0.1637	0.1636	0.1636	0.1637
Time-varing firm-level controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm and time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes

Notes : The figures in the table are fixed effect OLS coefficients and the figures in the parentheses are robust standard erros clustered at the firm level. *, **, *** indicates statistical significance at the 10%, 5%, 1% level, respectively. Every estimates represents the effect of 1-standard deviation increase of GPRNK index. All column include firm and time fixed effects and firm-level control variables. The sample covers 2006m1 ~ 2018m12. We use three-month moving-averaged index with window [t-1, t+1] in column (1) and (2), [t-2, t] in column (3) and (4), weighted index by paid subscription in column (5) and standardized index in column (6), respectively.

Finally, Table 10 additionally control the interaction of firm-characteristics with another uncertainty measure of South Korean economy. In column (1) ~ (5) we control the effect of overall stock market volatility by adding VIX KOSPI index and its interactions with firm-level possible sensitivity variables. We still find strongly significant coefficients on GPRNK interactions except for interactions with fixed-to-total asset ratio and defense dummy. The coefficients on VIX are insignificant or show opposite sign with GPRNK, implying that firm-level stock market reaction to geopolitical risk is quite different from reaction to total market volatility. And now the average GPRNK effect is also estimated to be negative. We can comment that after removing the effect of market uncertainty, escalation of geopolitical risk associated with North Korea reduce average stock return of South Korean firms. Column (6) ~ (10) further control the effects of economic policy uncertainty (EPU) index of South Korea presented by Baker Bloom and Davis (2016). We find that the inclusion of EPU does not change much the estimates on GPRNK in column (1) ~ (5).

Table Ⅰ-10. Robustness 4: Control Other Sources of Uncertainty

Dependent Variable : Monthly stock returns	Control for Market volatility					Control for Economic Policy Uncertainty				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
GPRNK	-0.0019***					-0.0015***				
	(0.0003)					(0.0003)				
GPRNK * Foreigner ownership		0.0005**			0.0015***		0.0007***			0.0015***
		(0.0002)			(0.0003)		(0.0002)			(0.0003)
GPRNK * log(asset)			-0.0010***		-0.0016***			-0.0007***		-0.0013***
			(0.0002)		(0.0003)			(0.0002)		(0.0003)
GPRNK * (Fixed asset/Total asset)			-0.0023		-0.0021			-0.0022		-0.0020
			(0.0019)		(0.0019)			(0.0019)		(0.0019)
GPRNK * Ecoop dummy				-0.0110***	-0.0098***				-0.0112***	-0.0103***
				(0.0016)	(0.0016)				(0.0016)	(0.0016)
GPRNK * Defense dummy				-0.0026	-0.0014				-0.0020	-0.0011
				(0.0019)	(0.0019)				(0.0020)	(0.0019)
VKOSPI	-0.0404***					-0.0373***				
	(0.0017)					(0.0017)				
VKOSPI * Foreigner ownership		0.0037***			0.0003		0.0041***			0.0003
		(0.0008)			(0.0010)		(0.0008)			(0.0010)
VKOSPI * log(asset)			0.0060***		0.0057***			0.0067***		0.0066***
			(0.0008)		(0.0011)			(0.0008)		(0.0011)
VKOSPI * (Fixed asset/Total asset)			0.0056		0.0052			0.0061		0.0056
			(0.0069)		(0.0072)			(0.0069)		(0.0072)

Table Ⅰ-10. Robustness 4: Control Other Sources of Uncertainty (continued)

Dependent Variable : Monthly stock returns	Control for Market volatility					Control for Economic Policy Uncertainty				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
VKOSPI * Ecoop dummy				-0.0016	-0.0068				-0.0023	-0.0083
				(0.0048)	(0.0049)				(0.0052)	(0.0052)
VKOSPI * Defense dummy				0.0234***	0.0168***				0.0250***	0.0175***
				(0.0059)	(0.0061)				(0.0063)	(0.0064)
EPU						-0.0141***				
						(0.0009)				
EPU * Foreigner ownership							-0.0013**			0.0002
							(0.0006)			(0.0007)
EPU * log(asset)								-0.0023***		-0.0025***
								(0.0007)		(0.0009)
EPU * (Fixed asset/Total asset)								-0.0017		-0.0014
								(0.0055)		(0.0057)
EPU * Ecoop dummy									0.0022	0.0046
									(0.0039)	(0.0039)
EPU * Defense dummy									-0.0050	-0.0022
									(0.0050)	(0.0050)
Number of Observations	244,372	243,783	244,372	244,372	243,783	244,372	243,783	244,372	244,372	243,783
Number of firms	2,278	2,269	2,278	2,278	2,269	2,278	2,269	2,278	2,278	2,269
Adjusted R2	0.073	0.163	0.164	0.163	0.164	0.074	0.163	0.164	0.163	0.164
Time-varing firm-level controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effects	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes

Notes : The figures in the table are fixed effect OLS coefficients and the figures in the parentheses are robust standard erros clustered at the firm level. *, **, *** indicates statistical significance at the 10%, 5%, 1% level, respectively.The dependent variable is monthly stock return. The coefficients on GPRNK and its interactions represent the effects of 1-standard deviation increase of GPRNK index. All columns include firm and time fixed effects. To control the response of stock price to another source of uncertainties, column (1)~(5) inclued VKOSPI and its interactions with firm-level explanatory variables and (6)~(10) also include EPU and its interactions

5. Conclusion

We develop a new measure of geopolitical risk associated with North Korea based on media coverage over the last two decades. Our index captures both of tension-increasing and tension-decreasing components and comprehensive North Korea-related risk factors such as war threat, WMD development, sanctions, talks and economic cooperation.

The firm-level regression results indicate that increasing geopolitical uncertainty in Inter-Korean relations depresses stock returns especially for the firms that have dominant share of domestic investors, large irreversible asset and experience of involvement in Inter-Korean economic cooperation. This results implies that investment irreversibility and international portfolio diversification are important channel that explain firm's stock price reaction to country-specific geopolitical uncertainty.

With the recent development of new approach using text data, measurements of various sources of uncertainties and their economic impacts have been advancing in economic literature. Inter-Korean relations are a valuable case for studying regional-specific geopolitical risk with its historical and political uniqueness. This study is expected to contribute to understanding the economic consequences of country-specific geopolitical risk.

This paper can also contribute to the studies on economic reaction of South Korea to North Korean threat as a complement of existing event studies. We provide an alternative approach that can take the contextual diversity into account to present more persistent effects and different stock price reaction by firm-characteristics.

II. Decomposing North Korea's Trade with China and Revisiting Sanction Effects

1. Introduction

North Korea's trade with China has rapidly increased both in value and share for the last two decades. China accounted for 20~30% of North Korea' trade in early 2000s, which has grown to 60~70% in 2010s.[12] Annual volume of China-North Korea trade amounts 500 million USD in 2000 and became 7 billion USD in 2014. As of 2018, North Korea trade with China amounts 2.7 billion USD and shares 94% of total trade of North Korea although it was fell by half after the multilateral sanctions that blocked most of major exporting products of North Korea.

The rising trend of China's share is largely due to the isolation from alternative commercial partners such as Japan and South Korea, both of which were once largest importers of North Korean goods and imposed trade embargoes facing geopolitical frictions with North Korea. North Korea's trade with Japan fell sharply after 2003, when Japan strengthened state control inspections on the North-Korean ferry, Mankyongbong-92, to pressure North Korea in negotiations over abduction issue. The complete trade embargo was imposed after the 1st nuclear test of North Korea, in 2006. Similarly, Inter-Korean trade was suspended except for Kaesung Industrial Complex(KIC) in the aftermath of North Korea's torpedo attack on the Cheonan

[12] The share of China is defined as China's trade volume with North Korea denominated by total trade of North including Inter-Korean trade. The calculation is based on KOTRA estimation of North Korea's foreign trade and the Inter-Korean trade data published by South Korean Ministry of Unification.

battleship in 2010 and completely banned including KIC after 4th nuclear test in January 2016.

These unilateral measures are considered to have little impacts on North Korean economy because the increase in North Korea's trade with China was much greater than the decrease in trade with other partners. In particular, North Korea bypassed the sanctions by bonded trade that China re-exports the imported products from North Korea to third countries including South Korea and Japan (Jung, 2016; Choi et al., 2016). Table 1 shows that the loss from exports to the sanction-imposing country is only about one-third of the gain from exports to the friendly countries.

Table Ⅱ-1. Export Substitution after Unilateral Sanctions

Panel A : Japanese sanctions

	Japan	South Korea	China
2003-2005 average	156	289	493
2006-2008 average	26	570	601
Difference	(-130)	(+281)	(+108)

Panel B : South Korean sanctions

	South Korea	China
2007-2009 average	590	710
2010-2012 average	113	2,049
Difference	(-483)	(+1,339)

Source : KOTRA, Ministry of Unification

Note : The unit of figures in the table is million $. Exported value to South Korea include general and processing trade outside Kaesung Industrial Complex.

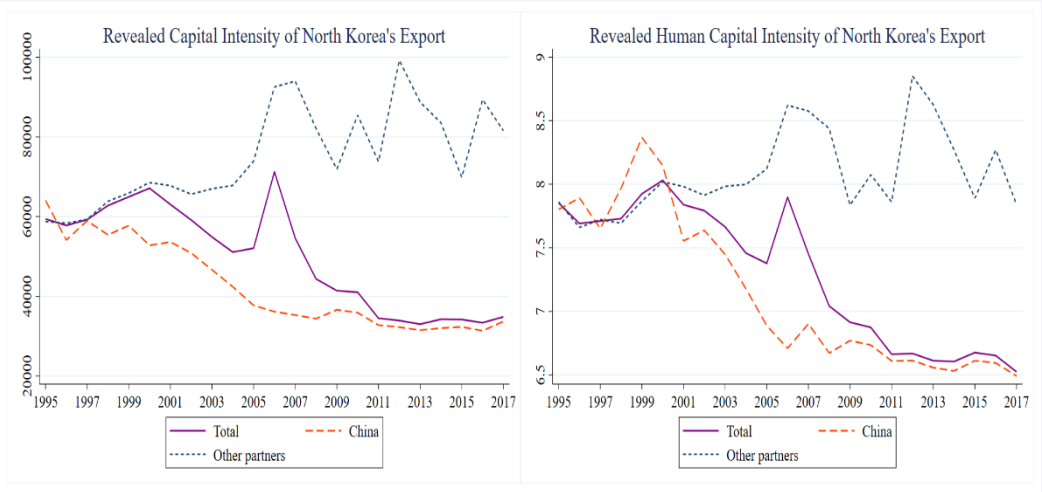
However, the isolation from neighboring countries may have induced following implicit cost to North Korea. First, North Korea may not have substituted but simply lost its important commercial partners. Recent studies point out that the main determinants of the rapid increase in China-North Korea trade are external conditions such as economic growth and demand for mineral resources of China or rising international coal price, rather than North Korean policy. (Kim, 2013a; Lee, 2015;

Choi et al. 2015).[13] The unilateral sanctions probably induced opportunity cost because North Korea could have increased trade with China without losing commercial relationship with South Korea and Japan.

Second, the inordinate dependence on China may cause qualitative decline in foreign trade of North Korea. For example, Kim (2018) points out that the quality of North Korea's export structure, measured by the weighted-average of revealed factor intensity, has worsened since late 2000s. Figure 1 implies that the decrease in revealed capital intensity and human capital intensity of North Korea's export is associated with the increasing dependence on China because exports to the other countries exhibit consistent and much higher factor intensities than China. This can be interpreted that North Korea's export structure has changed to meet the demand of China, resulting in concentration on mining and textile processing industry that does not require (human) capital accumulation much. Furthermore, relying on a single country may worsen terms of trade. Koh et al. (2008) and Kim (2017) show some anecdotal evidences that North Korea exports its products to China at relatively low price because of weak bargaining power.

[13] Kim(2013) suggests that China's economic growth and increased purchasing power led to expanded import from neighbor countries and finds that China's trade with Southeast Asian countries grew faster than trade with North Korea. Lee(2015) finds that the most important determinant of North Korea's anthracite export is steel production of Chinese firms and Choi et al.(2015) suggest that the growth in the anthracite exports become stagnant due to the changes in environmental policy of China.

Figure II-1. The Factor Intensity Indices of North Korea's Exports



Note : Author's calculation based on UN Comtrade database and methodology of Kim(2018).

To take these possible implicit costs into account, I suggest an alternative approach that evaluates North Korea's trade with China compared to China's trade with the other partners and that measures not only the quantity but also qualitative or structural aspects of trade. More specifically, this paper reassesses the effects of sanctions on North Korea focusing on the quality of trade, proxied by product diversity and relative unit value.

The importance of the extensive margin in international trade was highlighted by recent trade literature both theoretically and empirically. Theoretical models with heterogeneous firms predict that changes in the trade barriers have an effect on the extensive margin (Melitz, 2003; Arkolakis, 2010). Employing disaggregated information on trade, researchers also presents empirical evidences that the extensive margin is associated with trade growth (Hummels and Klenow, 2005; Kehoe and Ruhl, 2013), total factor productivity of exporting countries (Feenstra and Lee, 2008), consumer's welfare of importing countries (Broda and Weinstein, 2006), and economic growth (Hesse, 2009).

Relative unit values can reflect product quality or the productivity of exporters. Schott (2004) suggests that within-product specialization explains variation of unit value across countries better than across-product specialization, that is, more productive exporter can set higher prices on its products. Similarly, Hummels and Klenow (2005) shows that big and rich countries export commodities at a relatively high prices, which is contradict to classical trade theories that predict the price elasticity with respect to GDP per worker to be zero or negative. This can be explained by a model allowing quality variation across countries. According to the authors' calibration, the price elasticity, if adjusted by products quality, is now estimated to be negative.

In this paper, we use China product-level trade data – disaggregated at the eight-digit Harmonized Commodity Description and Coding System (HS 8 digit) – to decompose North Korea's trade with China, relative to the other partners, into the three parts, extensive margin, price and quantity; the latter two are parts of the intensive margin. We then re-examine the effects of sanctions from the former important trade partners of North Korea, i.e Japan and South Korea, using the results from the decomposition and also evaluate the effectiveness of the newly-imposed multilateral sanctions after 2016.

The main focus of this study is to check whether there is any qualitative decline in North Korea's foreign trade associated with isolation from neighbor countries. To achieve this goal, we estimate the sanction-induced changes in the extensive margin and the relative unit price of North Korea's export to China.[14] Most of previous studies have reached a consensus that the expanded trade with China was enough to offset the effects of sanctions in terms of the gross trading volume (Haggard, and Noland 2009;

[14] In trade literature, the general usage of the term 'exports quality' is limited to the quality of exporting products, which is inherent in the relative price but this paper uses the term in broader meaning that what is components of exports other than quantity.

CRS 2010; Lee et al., 2010; Lee, and Lee 2012, Jung, 2016; Choi et al., 2016).[15] Since these evaluations do not distinguish the quality and quantity of the trade, our new approach is expected to contribute to the understanding on the sanction effects on North Korean economy.

Employing dynamic panel data regression model, this paper presents following main results. First, the extensive margin of North Korea's export to China doesn't increase after the trade sanctions from Japan and South Korea, which implies that the diversity of exporting items of North Korea has been narrowed by those unilateral measures. Second, the sanction imposed by the United Nations Security Council (UNSC) in 2017 further reduced the varieties of North Korean exports by 2/3. Third, the relative price of North Korea's exports to China also exhibits significant decrease after the sanctions, especially for the commodities that have been exported to sanction-imposing countries, suggesting that China's demand monopoly may undermine the bargaining power of North Korea.

2. Decomposing North Korea's Trade with China

This chapter decomposes North Korea-China trade into extensive margin, price and quantity to examine main driving factor of the overall growth of the bilateral trade. To do so, we use the methodology pioneered by Feenstra (1994) and Hummels and Klenow (2005), which is applicable even under limited availability and possible inaccuracy of trade data on North Korea.[16]

15 Multilateral sanctions are believed to have a considerable pressure on North Korean economy after 2017, when the United Nations Security Council that officially prohibits its members importing North Korea's major exporting items without exception. For details, see Lee(2017), Kim et al. (2018), Kim(2018) and Lee(2019).

16 Inspired by the work of the authors, researchers in the field of international trade have suggested more developed measurements of extensive margin, price and product quality. Most of the methods, however, are not suitable for North Korea because their significant data requirements cannot be satisfied. (Hallak and Schott, 2011; Silva et al, 2014).

2.1. Data

This study employs product-level trade data from Chinese Custom Statistics, provided by Korean International Trade Association (KITA). The data are presented in the Harmonized System (HS) classification code at the eight-digit level, the most disaggregated classification KITA provides. The data include annual value and quantity of 11,194 commodities China's exported and 10,547 commodities China imported, over the sample periods 1998~2018. Prices are measured by unit values (value/quantity), generating some missing values due to the absence of quantity data, which counts 13 commodities for export and 66 commodities for import.

As information on Chinese trade by partner country is also available in KITA, we extract trade with North Korea and with rest of the world (ROW, hereafter) for comparison. Figure 2 and Figure 3 present some descriptive patterns of North Korea's trade with China.

The left panel of Figure 2 shows that NK's relative volume of export to China has grown while that of import from China has not changed much in the last two decades. The export exhibits sharp increase from 2000 to 2004 and from 2010 to 2016, followed by sudden crash after 2017. The right panel presents number of HS-8 digit commodities NK traded with China. The number of items NK imported from China is much greater and exhibit larger increase than the number of product NK exported to China. From this, we can expect that North Korea's export growth is mainly attributed to the extensive margin while the import growth to the intensive margin.

Figure II-2. Descriptive Patterns 1

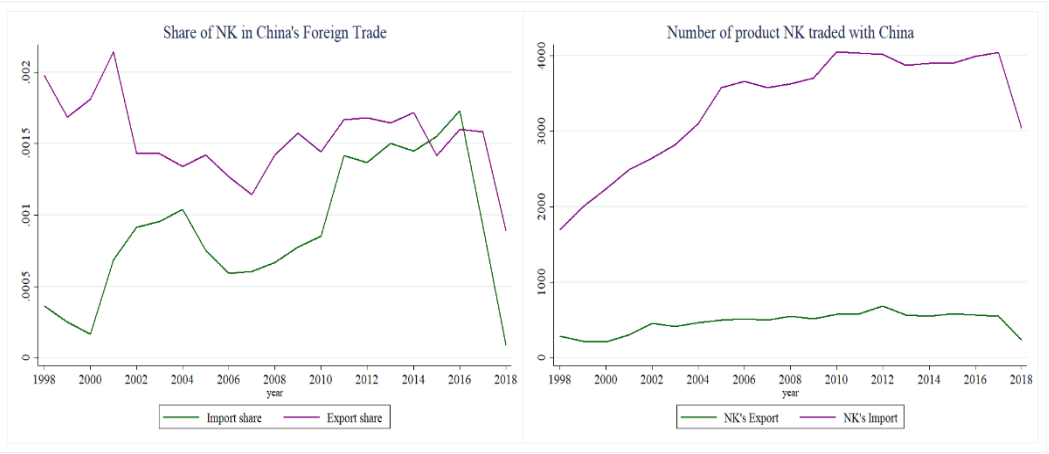
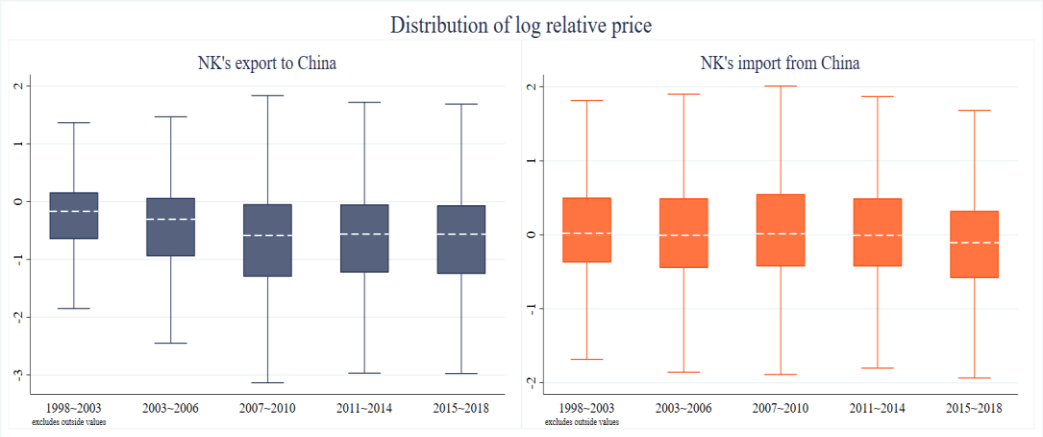


Figure 3 displays the distributions of North Korea's exporting and importing price relative to those of ROW and their transition over time. North Korea's export prices to China tend to substantially lower than that of the other partners of China: the 75 percentile of log relative commodity prices below or close to 0. [17] In addition, the distribution further moves downward after mid-2000s when China become the top importer of North Korea. For North Korea's import, on the other hand, the distribution almost centered at zero and does not show any notable change over time. We discuss the trend of relative price again from the decomposition results in the next section.

[17] The log relative price of each commodity is calculated as log of North Korea's exporting price subtracted by log of average exporting price of ROW.

Figure II-3. Descriptive Patterns 2: Relative Unit Price



Notes : This figure displays the distribution of relative unit value of North Korea's trade with China. The bottom and top borderlines of boxes indicate 1st and 3rd quartiles, respectively. I exclude the outliers of which distance with median exceed 1.5 times of 3rd quartile or 1st quartile.

Previous studies on the China-North Korea trade have found some inaccuracies in the data. We consider these concerns to modify the dataset as follows. First, China's trade with North Korea was not recorded from August to November in 2009. Fortunately, there are some evidences China reported trade with North Korea on the 'Other Asian, not elsewhere specified' account during that periods (Nam, 2015; Lee, 2016). We accept the finding to add China trade with 'Other Asian, nes' to China-NK trade in 2009.

Second, there are no data on North Korea's crude oil import from China since 2014. Since we do not observe any symptom suggesting stoppage of oil supply in North Korean economy, it is plausible that China exports crude oil to North Korea in a similar scale. So, we take the estimates of Korea Trade-Investment Promotion Agency (KOTRA) that North Korea keep importing crude oil 500~525 thousand tons a year.

Third, North Korea's memory chip (HS 854230) export to China surges in 2001, which was not likely products of North Korea, given the capital and technology constraints (Kim, 2013). However, modifying or eliminating an observation in a specific period may hurt consistency of the data because the memory chip exports are continuously observed over the sample periods. So, we use the trading value as it is recorded, but treat the prices of the commodity as missing.

Fourth, there may be errors in measuring price due to quantity unit inconsistency or mis-recording. To reduce the concern about measurement error in the prices, I employ some screens when calculate the price index. Specifically, I eliminate following 'suspect' observations: (i) artworks (HS 97) or unclassified goods (HS 98~99), (ii) items with annual trade volume below $5,000 or trade quantity is just one unit, (iii) items with extreme relative prices (North Korean price above 10 times or below 1/10 of ROW's price). Throughout this procedure the 33% of commodity-year observations of North Korea's import and 38% of observations of North Korea's export are dropped.

2.2. Methodology

The methodology of this study is guided by Hummels and Klenow (2005). We start with defining the extensive margin and the intensive margin. Suppose we consider North Korea's export to country m with reference of country k.[18] If the North Korea's exporting items to m are a subset of k's exporting items to m, the extensive margin defined as follows:

$$EM_{nm} = \frac{\sum_{i \in I_{nm}} p_{kmi} q_{kmi}}{\sum_{i \in I} p_{kmi} q_{kmi}} \quad (1)$$

[18] The methodology is developed to evaluate a country's exports with the reference of ROW but we also present the decomposition result of North Korea's import from China for comparison.

Where p is price, q is quantity, I and I_{nm} denotes an universal set of product categories and a set of product categories that North Korea exports positive value to m respectively. So, the extensive margin can be thought as a weighted count of North Korea's exporting items relative to k's exporting items with the weight of their share in k's exports to m. The intensive margin equals North Korea's nominal exporting volume relative to k's nominal exporting volume within I_{nm} (categories in which North Korea has positive exports to m).

$$IM_{nm} = \frac{\sum_{i \in I_{nm}} p_{nmi} q_{nmi}}{\sum_{i \in I_{nm}} p_{kmi} q_{kmi}} \quad (2)$$

The intensive margin is decomposed into two parts: price and quantity. The price index is defined as a weighted geometric mean of relative commodity prices country m import from North Korea versus country k:

$$P_{jm} = \prod_{i \in I_{nm}} \left(\frac{p_{nmi}}{p_{kmi}}\right)^{w_{nmi}} \quad (3)$$

The weight in the price index, w_{nmi}, is the logarithmic mean of the share of commodity *i* in North Korea's export to m and the share of commodity *i* in k's export to m:

$$w_{nmi}{}^{19} = \frac{\frac{s_{nmi} - s_{kmi}}{\ln s_{nmi} - \ln s_{kmi}}}{\sum_{i \in I_{jm}} \frac{s_{nmi} - s_{kmi}}{\ln s_{nmi} - \ln s_{kmi}}} \quad (4)$$

where $s_{nmi} = \frac{p_{nmi} x_{nmi}}{\sum_{i \in I_{nm}} p_{nmi} x_{nmi}}$, $s_{kmi} = \frac{p_{kmi} x_{kmi}}{\sum_{i \in I_{nm}} p_{kmi} x_{kmi}}$

Then, the quantity index is derived as a residual part of the intensive margin:

$$IM_{nm} = P_{nm} * Q_{nm} \quad (5)$$

[19] More precisely, it is defined as normalized value of the logarithmic mean, summation of which over commodities is to 1.

In sum, North Korea's export to m, with reference of k, is decomposed into the three components: extensive margin, price and quantity.[20]

$$\frac{\sum_{i\in I_{nm}} p_{nmi}q_{nmi}}{\sum_{i\in I} p_{kmi}q_{kmi}} = EM_{nm}IM_{nm} = EM_{nm} * P_{nm} * Q_{nm} \quad (6)$$

2.3. Decomposition Results

This section presents the trend of each decomposed component of North Korea's trade with China, and figure out the main driving factor of overall trade growth.

Figure 4 shows the result from decomposing extensive margin and intensive margin. In the left panel, the extensive margin of North Korea's export to China exhibit flat trend since late 2000s, while the extensive margin of import is steadily increasing. As of 2016, North Korea imports most of main exporting items of China with the extensive margin about 0.9, while has not entered China's import market for a considerable number of sectors; the extensive margin is only about 0.3. The right panel shows that the intensive margin is the main driving factor of exports growth of North Korea, especially from 2007 to 2016. Interestingly, after 2017, when the multilateral sanctions imposed to block North Korea's main exporting items, most of the decrease in the trade is observed in the intensive margin for North Korea's, while observed in the extensive margin for North Korea's import.

Figure 5 decomposes the intensive margin into price index and quantity index. It shows that recent growth in North Korea's export is mostly explained by increase in the quantity, while the price index exhibit decreasing trend since early 2000s. Furthermore, the price index of North Korea's export is below 1 throughout the sample period, implying China imports from North Korea at a lower price than other partners in average.

20 In practice, m and k denotes China and rest of the world, respectively.

Figure II-4. Decomposition Results: Extensive and Intensive Margin

Figure II-5. Decomposition Results: Price and Quantity

In figure 6, we measure the price index and the quantity index again after eliminating outliers in relative prices. The exclusion of outliers shifts the import price index slightly downward, but has little impacts on the trend of export price index.

The price index may contain products quality and quality-adjusted price that cannot be calculated with our dataset.[21] A good example for understanding North Korea's export prices is comparing coal and apparels. North Korea's anthracite export to China has rapidly increased especially after 2010 to be the most important source of foreign currency in North Korean economy. However, the price tends to be significantly lower than that of Russia and Australia, the other main exporters of anthracite, and even than international price that doesn't include cost, insurance and freight (Kim, 2017). Since there is no evidence of substantial difference in anthracite quality between North Korea and the other exporters, the difference in observed price can be attributed to pure price gap.[22]

Similarly, North Korea exports apparels to China at much lower prices than that of the other countries. For example, North Korea's average unit price in exporting *men's or boys' anoraks, wind-cheaters of man-made fibers (HS 62019390)* to China is 17.56 USD/n in 2014, which is about 60% of that of Vietnam. There is now room for thinking of the price gap partly attributed to the qualitative difference because of much broader within-product quality spectrum in apparels than in mining products.

[21] The methodology for decomposing relative price into pure price index and product quality is recently developed based on theoretical model of microeconomic foundation and detailed trade information on broad country-pair sample. (Hallak and Schott, 2011; Feenstra and Romalis, 2014; Henn et al., 2013). The largest hurdle in applying those estimation strategies to North Korea is the availability and credibility of trade data. (Lee et al., 2010)

[22] There are some hypotheses that explain the pure price gap in export price of anthracite. One possible explanation is the existence of bribery (kickback) in North Korea's export to China that North Korean exporter set the price of anthracite below market price to take the 'kickback' (Kim and Jung, 2015). An another hypothesis is about the bargaining power of China over North Korea. For more detailed explanation, see Kim(2017).

Figure II-6. Decomposition Results: Price and Quantity (excluding outliers)

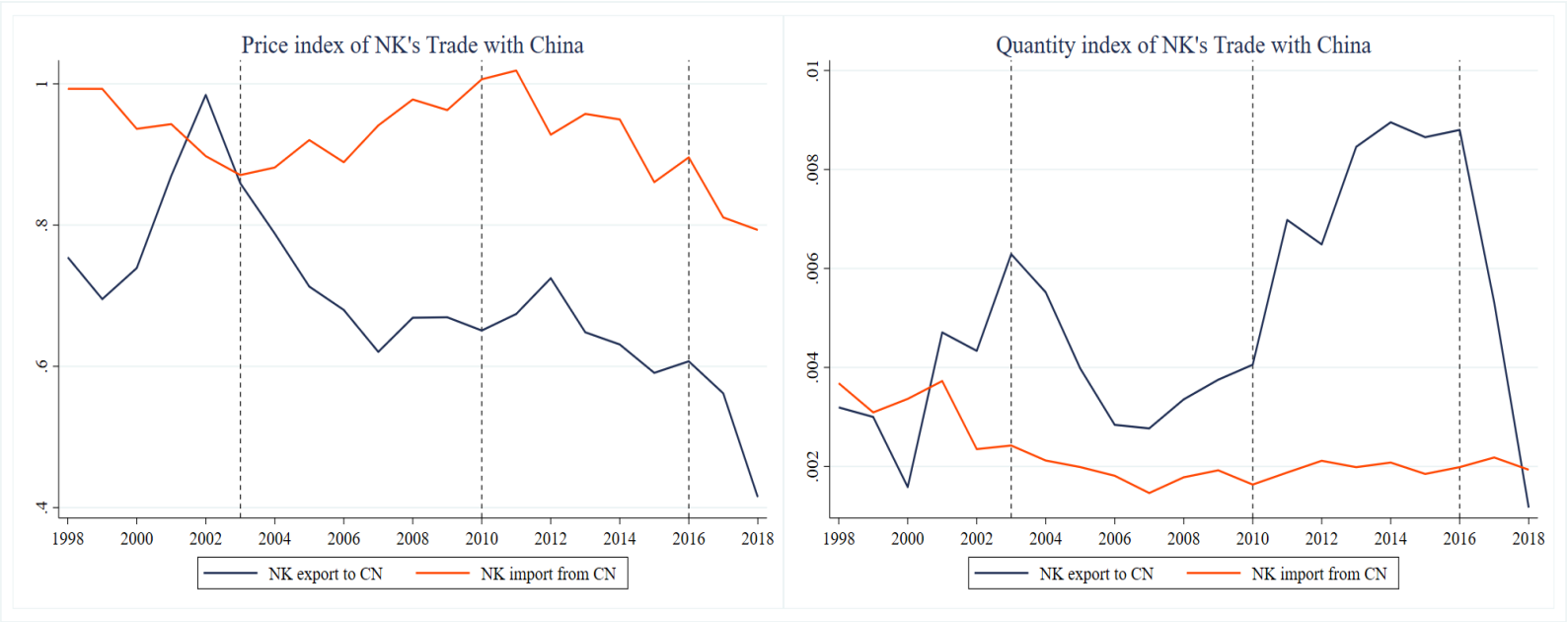


Table 2 displays the result of decomposing North Korea's export and import growth. The first column contain the growth rate of North Korea's trade with China,[23] which is decomposed into the growth of China's trade with ROW (column 2) and the relative growth of trade with North Korea (column 3). The exports of North Korea have grown rapidly relative to ROW while the relative growth in the import is not impressive. Column (4) ~ (7) decomposes the relative trade growth into extensive margin and intensive margin (the latter is further decomposed into price and quantity). The decomposition implies that the relative growth of the export is mostly driven by the quantity margin, given that the extensive margin and the price index exhibit negative or moderate growth when the relative export grows rapidly. In other words, the growth rate of quantity index exhibits the closest co-movement with that of total export to China, suggesting that existing literature mainly capture the variations in quantity.

[23] Before the calculation, I convert the trade volume from nominal value to real value by denominating it with CPI of United States.

Table Ⅱ-2. Decomposing Growth rate of North Korea's Trade with China

Panel A. Export

	G_NK	G_ROW	G_r	G_em	G_im	G_p	G_q
1998-2003	38.51%	19.15%	19.36%	3.21%	16.15%	2.60%	13.55%
2003-2007	6.63%	17.99%	-11.36%	17.27%	-28.63%	-8.13%	-20.50%
2007-2010	22.17%	10.91%	11.26%	-3.04%	14.30%	1.58%	12.71%
2010-2013	27.65%	8.78%	18.86%	-5.51%	24.37%	-0.13%	24.49%
2013-2016	-4.33%	-9.10%	4.77%	5.64%	-0.86%	-2.18%	1.32%
2016-2018	-132.50%	14.33%	-146.83%	-26.84%	-120.00%	-19.03%	-100.98%

Panel B. Import

	G_NK	G_ROW	G_r	G_em	G_im	G_p	G_q
1998-2003	8.88%	15.33%	-6.45%	4.53%	-10.98%	-2.62%	-8.36%
2003-2007	16.90%	22.55%	-5.64%	5.02%	-10.66%	1.94%	-12.60%
2007-2010	14.77%	6.99%	7.78%	1.85%	5.93%	2.24%	3.69%
2010-2013	13.32%	8.98%	4.34%	-0.48%	4.82%	-1.66%	6.48%
2013-2016	-2.99%	-2.16%	-0.83%	1.37%	-2.21%	-2.22%	0.01%
2016-2018	-17.38%	5.47%	-22.85%	-15.41%	-7.43%	-6.09%	-1.34%

Notes

1. All figures represents growth rates in log percentage.
2. G_NK : growth of North Korea's export to China, G_ROW : growth of ROW's export to China, G_r : relative growth of North Korea's export to China
3. G_em : growth of extensive margin, G_im : growth of intensive margin, G_p : growth in price , G_q : growth in quantity

3. Panel Regression Analysis

In this section, we revisit the effects of sanctions on North Korea's export to China, using the decomposition results. Unlike the previous studies that focused on trade quantity, this paper assesses the effects of international isolation on trade quality, i.e, the extensive margin and the relative unit price. To construct a panel setting, we apply the EM-P-Q decomposition to North Korea's export to China in each HS 2-digit item group rather than total export.[24] After the sectors that doesn't contain positive value over the sample periods are excluded, the resulting dataset includes 1974 observations from 94 item groups over 1998~2018.

3.1. Empirical Framework

Our baseline regression model is set to assess the average effects of sanctions across sectors. We use a similar methods of Jung (2016) that explore the effects of sanctions on product level trade volume between North Korea and China. The key outcome variables EM_{it} and P_{it} are obtained from sector-level decomposition results and denotes the extensive margin and the price index of North Korea′s export to China in sector $\boldsymbol{i}$ in year t, respectively. In regression model, we take natural logarithm on both of outcome variables to measure the effects in percentage changes. About 25% of the sector-time observations are missing values (zero-trade between North Korea and China). Unlike in the relative prices, zeros in the extensive margin may have valuable information. So, we add 0.01 before taking log-transformation.

For the effects of sanctions, we only focused on the measures that directly targeted general exporting items rather than military or luxury goods. Thus, the sanctions by UNSC Resolutions in response to North Korea's nuclear and missile test before 2017

[24] This section considers HS 2-digit classification as correspondent of sector or industry classification.

is not included in the regression, because they did not included sanctions on non-military commercial trade or gave exception for livelihood-purposed trade that nullified sanction effects. We only consider sanctions imposed by Japan from 2003, by South Korea from 2010 and by UNSC in 2017. In practice, sanction dummy variables are employed to capture the persistent effects of each measure until it is lifted: dJP_t , dSK_t and dUN_t denotes indicator that takes 1 if year>=2003, if year>=2011 and if year>=2017, respectively.

The regression also includes the following control variables for another possible sources of variation in the extensive margin and the relative price. First, the lagged variables, EM_{it-1} and P_{it-1} are included to control the common trends in the outcome variables and to consider the dynamic interaction between sanctions and the qualitative aspects in North Korea-China trade. We estimate this dynamic model using system generalized method of moments (GMM) estimator to reduce the inconsistency problem induced by including both of individual fixed effects and lagged dependent variable.

Second, we consider the demand and supply side of North Korea's export to China characterized by IM_{it} and EX_{it}. The former is total imports of China (from the world) in sector $\boldsymbol{i}$, which reflects demand of Chinese import market for commodities in the sector. The latter denotes total exports of North Korea (to the world) in sector $\boldsymbol{i}$, which is related to North Korea's capacity or willingness to export in the sector.

Third, the reaction of North Korea's trade to external economic shock is considered in the regression. For North Korea, Mineral exports account for more than half of total exports and serve as the most important source of hard currency inflows (Lim et al., 2017). So, we include CP_t, the AR(1) residual of world coal prices index included to capture the shock from international price fluctuation.

In sum, we propose following baseline regression models to estimate the average effects of sanctions on the extensive margin and the relative price index.

$$\ln EM_{it} = \alpha + \beta_1 \ln EM_{it-1} + \beta_2 dJP_t + \beta_3 dSK_t + \beta_4 dUN_t$$

$$+ \gamma_1 lnIM_{it} + \gamma_2 lnEX_{it}{}^{25} + \delta CP_t + \mu_i + \varepsilon_{it} \quad (7)$$

$$\ln P_{it} = \alpha + \beta_1 \ln P_{it-1} + \beta_2 dJP_t + \beta_3 dSK_t + \beta_4 dUN_t$$

$$+ \gamma_1 lnIM_{it} + \gamma_2 lnEX_{it} + \delta CP_t + \mu_i + \varepsilon_{it} \quad (8)$$

Table 3 displays summary statistics of the variables in the equation (7) and (8) for the four sample periods separated by the three sanction indicators. The sample mean of extensive margin is 0.108 for 1998~2002, 0.176 for 2003~2010, 0.180 for 2011~2016 and 0.137 for 2017~2018, with which we expect β_2 of equation (7) to be positive and β_4 to be negative. Similarly, we can expect β_2 and β_4 of equation (8) to be negative because the sample mean is much smaller in 2003~2010 than in 1998~2002 and also in 2017~2018 than in 2011~2016.

25 Given that China is the top importer of North Korea, the total export of North Korea is naturally collinear with export to China and thus collinear with the extensive margin. The correlation should be very strong recently, since China have dominated share in North Korea's export. So, we first regress extensive margin on sanction dummies without the control of total exports of North Korea, and then regress again with the control. The coefficients of the former can be interpreted as the overall effects of the sanctions on extensive margin, while those of the latter as the residual effects after captured by the total exports.

Table Ⅱ-3. Summary Statistics

	1998~2002			2003~2010			2011~2016			2017~2018		
	# obs	Mean	SD	# obs	Mean	SD	# obs	Mean	SD	# obs	Mean	SD
Extensive margin	470	0.108	0.195	752	0.176	0.249	564	0.180	0.244	188	0.137	0.229
Log of price index	193	-0.212	0.812	454	-0.403	0.824	379	-0.500	0.697	100	-0.671	0.772
Import volume of China	470	19.729	2.019	752	20.791	2.143	564	21.628	2.036	188	21.784	2.036
Export volume of NK	470	13.969	2.939	752	14.316	3.070	564	14.366	3.438	188	6.648	7.224
Coal price shock	470	-0.244	0.115	752	0.154	0.315	564	-0.029	0.344	188	-0.117	0.051
Log of revealed capital intensity	300	10.946	0.690	569	10.823	0.822	426	10.837	0.869	125	10.868	0.817
Log of revealed human capital intensity	300	1.966	0.488	569	1.886	0.622	426	1.843	0.705	125	1.903	0.443

Notes. The sample covers item groups, aggregated at hs 2-digit level, that North Korea exported to China in at least one period over 1998~2018.

3.2. Baseline Results

Table 4 displays the baseline results on the extensive margin. The regressions are weighted by sector-level average trade volume, giving more weight to the important sectors in North Korea's export to China.

Column (1), (2) and (3) contain results from the pooled OLS, fixed-effect and system GMM estimation, respectively. The system GMM coefficient on the lagged dependent variable lies between the POLS and FE coefficient, suggesting that our regression can yield consistent estimators for equation (7) (Bond et al. 2001). Also, the three estimations all exhibit similar results with respect to the sanctions effects: only the sanctions from UNSC in 2017 have significant and negative impacts on the extensive margin of North Korea's export to China. The coefficients -1.15 ~ -1.21 can be transformed to 69~71% reduction in the extensive margin, which imply that the multilateral sanctions imposed by UNSC after 2017 cut the product variety of NK's export to China by 2/3. The non-significance of sanctions from Japan and South Korea is also interesting. We can suggest that North Korea's export product diversity become narrowed after the unilateral sanctions imposed by South Korea and Japan because the extensive margin of export to China does not increase after 2003 or 2010, considering that about half of varieties exported to Japan and ¾ of varieties to South Korea was non-traded goods with China.[26]

In column (4) ~ (6), we replace the Japanese sanction indicator with dummy variable that take value 1 if year>=2006, when Japan completely banned import from North Korea, rather than 2003. The results are not different statistically with those in column (1) ~ (3)

[26] Based on the HS 6-digit classification, 100 of 218 North Korean exports to Japan in 2002 and 686 of 916 North Korean exports to South Korea in 2009 were untraded with China.

Table Ⅱ-4. Sanctions and the Extensive Margin of NK's Export

Dependent variable : Log of extensive margin	POLS	FE	Sys GMM t-3	POLS	FE	Sys GMM t-3
	(1)	(2)	(3)	(4)	(5)	(3)
Log of lagged extensive margin	0.860***	0.580***	0.711***	0.857***	0.570***	0.704***
	[0.029]	[0.078]	[0.085]	[0.030]	[0.072]	[0.079]
Sanction from Japan (year>=2003)	-0.034	-0.064	0.055			
	[0.090]	[0.144]	[0.061]			
Sanction from Japan (year>=2006)				0.135	0.131*	0.189
				[0.125]	[0.069]	[0.117]
Sanction from South Korea	0.021	-0.047	0.070	-0.066	-0.072	-0.025
	[0.056]	[0.046]	[0.090]	[0.047]	[0.046]	[0.054]
Sanction from UN	-1.089***	-1.184***	-1.158***	-1.098***	-1.180***	-1.128***
	[0.201]	[0.189]	[0.215]	[0.198]	[0.192]	[0.196]
Log of imported value of China	-0.046*	0.045	-0.085	-0.052*	-0.013	-0.090
	[0.026]	[0.066]	[0.053]	[0.029]	[0.032]	[0.056]
Coal Price shock	0.064	0.021	0.182	-0.040	-0.038	-0.009
	[0.075]	[0.034]	[0.128]	[0.042]	[0.045]	[0.044]
Observations			1880			
Number of item groups			94			
Adj R2	0.780	0.438		0.781	0.439	
Hansen test			0.373			0.342
Arellano-Bond AR(2) test			0.385			0.321

Notes : The Dependent variable is natural log of extensive margin in NK's exports to China. Sanction from South Korea, UN is dummy variable having value 1 if year>=2011, year>=2017, repectively. Standard errors are calculated based on clustering at the industry level for POLS and FE regression and Windmeijer's finite-sample correction for system GMM. *, **, *** indicates statistical significance at the 10%, 5%, 1% level, respectively. All regressions are weighted by the industry's average trade volume between NK and China in the sample period.

Next, Table 5 regress the relative price index on sanction indicators and control variables. We further restricted the sample for the price index, considering the possibility that regression result is driven by non-important sectors that have extreme value. We drop sectors that average annual trade volume between North Korea and China is below 50,000 USD or average number of traded commodities is below 1. Also, the sample period is restricted to 2001~2018, because the composition of trade items between China and North Korea has changed greatly since 2001. In result, the sample size reduced to 720 observations of 54 HS-2 item groups.

The regression results in column (1) ~ (3) indicate that the sanctions from Japan have an impact on North Korea's relative export price. The price index of NK's export to China dropped 14~15% on average after 2003, when Japan started to take some measures equivalent to trade sanctions. This effect is persistent suggesting that North Korea lost the opportunity to increase its foreign currency imports by 14-15% annually after 2003. Recent sanctions from UNSC further reduce the relative price of North Korea's exporting products by 12~14%, but the estimates exhibit weak statistical significance.

Table Ⅱ-5. Sanctions and the Price Index of NK's Export

Dependent variable : Log of price index	POLS	FE	Sys GMM t-3	POLS	FE	Sys GMM t-3
	(1)	(2)	(3)	(4)	(5)	(6)
Log of lagged price index	0.797***	0.695***	0.763***	0.787***	0.682***	0.709***
	[0.028]	[0.070]	[0.155]	[0.025]	[0.064]	[0.171]
Sanction from Japan (year>=2003)	-0.167***	-0.149***	-0.157***			
	[0.035]	[0.040]	[0.033]			
Sanction from Japan (year>=2006)				-0.068	-0.065	-0.040
				[0.046]	[0.065]	[0.025]
Sanction from South Korea	0.030	0.017	-0.002	0.030	0.037	-0.026
	[0.033]	[0.023]	[0.050]	[0.040]	[0.027]	[0.050]
Sanction from UN	-0.151*	-0.155*	-0.134	-0.156*	-0.153*	-0.120
	[0.088]	[0.081]	[0.097]	[0.088]	[0.081]	[0.100]
Log of imported value of China	0.024**	0.024	0.017***	0.023*	0.007	0.019***
	[0.010]	[0.016]	[0.004]	[0.012]	[0.030]	[0.004]
Log of exported value of NK	-0.011*	-0.012**	-0.006	-0.011**	-0.012**	-0.006
	[0.006]	[0.005]	[0.008]	[0.006]	[0.005]	[0.008]
Coal Price shock	0.038	0.017	0.051	0.017	0.014	0.004
	[0.060]	[0.066]	[0.045]	[0.050]	[0.061]	[0.052]
Observations			720			
Number of item groups			54			
Adj R2	0.730	0.603		0.722	0.595	
Hansen test			0.312			0.522
Arellano-Bond AR(2) test			0.461			0.485

Notes : The Dependent variable is natural log of price index in NK's exports to China. Sanction from South Korea and UN is dummy variable having value 1 if year>=2011 and year>=2017, repectively. Standard errors are calculated based on clustering at the industry level for POLS and FE regression and Windmeijer's finite-sample correction for system GMM. *, **, *** indicates statistical significance at the 10%, 5%, 1% level, respectively. All regressions are weighted by the industry's average trade volume between NK and China in the sample period.

As is in the Table 4, column (4) ~ (6) of Table 5 set Japanese sanction indicator to be dummy variable for years after 2006. The coefficients are insignificant suggesting that Japanese sanctions induce structural change in North Korea's export price to China at 2003 rather than 2006, which is plausible given that North Korea's export to Japan had decreased sharply since 2003. So, we consider column (1) ~ (3) as the baseline results hereafter.

3.3. Possible Channels

As discussed above, North Korean exports are traded at relatively low prices in the Chinese import market and the price disadvantage is exacerbated by international economic sanctions. Now I investigate channels through which the trade sanctions affect the relative price of NK's exports to China. I provide three possible explanations of relative price decline and test one of them based on estimation of differential sanction effects by product characteristics.

The first hypothesis is that the quality of North Korean exports is relatively poor in the Chinese import market, and has worsened after the trade embargoes from the alternative trading partners. Given that the North Korean economy has been steadily recovering since the 2000s, and that the role of the private sector, which is presumably more productive than the state-owned sector, has increased in production and trade, the overall quality of North Korean exports is not likely to decline. However, China's rapid income growth and rising demand for high-quality products may have led to relative degradation of North Korean exports. Also, sanctions would block North Korea's economic cooperation with other countries, making North Korea unable to keep up with the rapid qualitative improvement of products in China's import market.

Second, if bribery in North Korea's export to China become more rampant, reported export prices can decrease to be far below the 'actual' price. It is well known that bribery is widespread and necessary for most of economic activities in North

Korea. According to the survey on Chinese firm involving business with North Korea, Chinese firms give bribes to North Korean officials for various purposes including maintaining rights to trade or setting favorable prices (Kim and Jung, 2015). Since the observed price in the dataset is the price declared to Chinese customs and does not include bribes, the actual price that Chinese importers pay for North Korean goods including bribe will be much higher than the declared.

The third hypothesis is that due to trade sanctions by neighboring countries, China virtually monopolize demand for most of North Korean exports, taking an advantage in price bargaining power. Koh et al. (2008) investigates top 25 products North Korea exported to China from 2001 to 2007 and suggests that the products with large Chinese share in North Korea's export tends to be traded at low and stable prices. Kim (2017) also argues that North Korea's anthracite export price is substantially lower than that of Russia and Australia in Chinese import market partly due to the monopolistic status of China in importing North Korea's anthracite.

The former two hypotheses are interesting and plausible, but the data coverage of this paper is not informative enough to test them. Thus, the rest part of the regression analysis focus on the third one, i.e., examining whether the bargaining power of China over North Korea associated with the dynamics of price setting before and after trade sanctions. To do so, I separate the sample products by dependence on sanction imposing countries before the sanctions. Specifically, I set 10% thresholds on the average share of Japan and South Korea in North Korea's export items for 5-years just before the sanction-enforcement.

Table Ⅱ-6. Sanctions and the Price Index of NK's Export: Subsample Regression

Dependent variable : Log of price index	Share JP < 10%		Share JP >= 10%		Share KR < 10%		Share KR >= 10%	
	FE	Sys GMM	FE	Sys GMM	FE	Sys GMM	FE	Sys GMM
Log of lagged price index	0.334***	0.411***	0.739***	0.900***	0.581***	0.647***	0.706***	0.734***
	[0.055]	[0.101]	[0.056]	[0.098]	[0.080]	[0.207]	[0.070]	[0.103]
Sanction from Japan	-0.075	-0.043	-0.160***	-0.214***	-0.115*	-0.115	-0.130	-0.153
	[0.080]	[0.145]	[0.046]	[0.053]	[0.064]	[0.093]	[0.103]	[0.097]
Sanction from South Korea	0.083	0.030	0.022	0.029	0.013	-0.018	0.051	0.079*
	[0.064]	[0.050]	[0.028]	[0.048]	[0.030]	[0.035]	[0.051]	[0.045]
Sanction from UN	0.010	0.004	-0.099	-0.045	0.024	0.057	-0.291***	-0.241***
	[0.078]	[0.081]	[0.089]	[0.112]	[0.058]	[0.135]	[0.054]	[0.057]
Log of imported value of China	-0.032	-0.031*	0.022	0.012	-0.012	0.019	0.047	0.014
	[0.036]	[0.016]	[0.021]	[0.010]	[0.018]	[0.029]	[0.044]	[0.016]
Log of exported value of NK	0.007	0.009*	-0.010*	-0.007	-0.003	-0.001	-0.018***	-0.010*
	[0.005]	[0.005]	[0.005]	[0.007]	[0.005]	[0.006]	[0.004]	[0.006]
Coal Price shock	-0.063	-0.091*	0.017	0.116	0.166**	0.163	-0.196**	-0.118
	[0.047]	[0.051]	[0.090]	[0.088]	[0.061]	[0.144]	[0.093]	[0.119]
Observations	412	412	308	308	239	239	481	481
Number of item groups	34	34	20	20	17	17	37	37
Adj R2	0.142		0.69		0.396		0.688	
Hansen test		0.628		0.576		0.395		0.447
Arellano-Bond AR(2) test		0.636		0.691		0.138		0.632

Notes : The Dependent variable is natural log of price index in NK's exports to China. Sanction from Japan, South Korea, UN is dummy variable having value 1 if year>=2003, year>=2011, year>=2017, repectively. Standard errors are calculated based on clustering at the industry level for POLS and FE regression and Windmeijer's finite-sample correction for system GMM. *, **, *** indicates statistical significance at the 10%, 5%, 1% level, respectively. All regressions are weighted by the industry's average trade volume between NK and China in the sample period.

Table 6 displays regression results by item groups. Column (1) ~ (4) separate item groups by the share of Japan in North Korea's export from 1998 to 2002. The results suggest that Japanese sanctions only affects the price index of item groups that was mainly exported to Japan, implying that declining relative export price to China is associated with loss of alternative export markets.

Similarly, Column (5) ~ (8) separate item groups by South Korea's share from 2006 to 2010. The price impact of sanctions from South Korea is not different by the former dependence of North Korea's exports on South Korea. Rather, the UN sanctions affect the export prices differently by item groups, showing only negative coefficients in the subsample of large share of South Korea. This results implies that not the 5.24 measure in 2010 but the suspension of KIC in 2016 lower the bargaining power of North Korea in export to China. The insignificance of the effect of 5.24 measure is not surprising, given that Inter-Korean trade volume recovered quickly after 5.24 measure by increasing production in the KIC.

In table 7, we estimate differential effects of sanctions by including interaction terms of sanction indicators and various product characteristics in regression equation. Column (1) and (2) interact Japanese sanction dummy and product-level dependence of North Korea's exports on Japan to check the bargaining power hypothesis again. We confirm the results of Table 6, that the items exported a lot to Japan showed a large drop in relative prices after Japanese sanctions imposing.

Column (3) and (4) test alternative hypothesis that sanctions have more price impacts on low-skill, low-technology sectors. We interact Japanese sanction dummy with revealed capital intensity and revealed human capital intensity of each HS 2-digit sectors. The human capital intensity interaction exhibits positive and significant coefficient, implying that North Korea have more disadvantage in export prices of products in sectors with low-skilled labor.

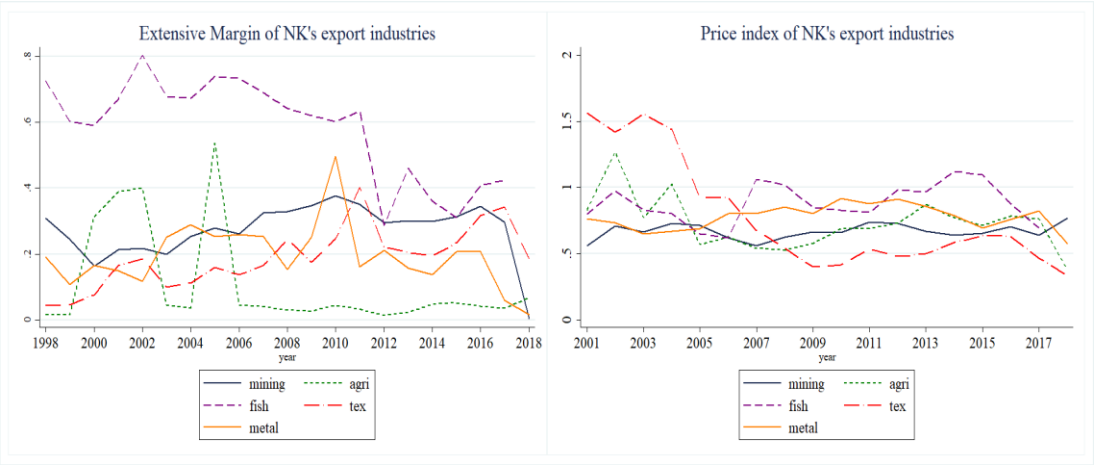
Table Ⅱ-7. Sanctions and the price index of NK's Export: Regression with Interactions

Dependent variable : Log of price index	(1)	(2)	(3)	(4)
Log of lagged price index	0.701***	0.702***	0.700***	0.702***
	[0.066]	[0.064]	[0.067]	[0.066]
Sanction from Japan	-0.058	-0.079*	-0.184**	-0.476***
	[0.056]	[0.043]	[0.088]	[0.139]
Sanction JP * 1(former share of JP>0.1)	-0.104*			
	[0.061]			
Sanction JP * former share of JP		-0.227*		
		[0.131]		
Sanction JP * revealed capital intensity			0.009	
			[0.018]	
Sanction JP * revealed human capital intensity				0.047**
				[0.018]
Log of imported value of China	0.031*	0.035*	0.031*	0.037**
	[0.017]	[0.018]	[0.016]	[0.016]
Log of exported value of NK	-0.027*	-0.033*	-0.027*	-0.030**
	[0.014]	[0.017]	[0.013]	[0.014]
Coal Price shock	0.032	0.033	0.032	0.032
	[0.062]	[0.063]	[0.062]	[0.062]
Observations	688	688	688	688
Number of item groups	54	54	54	54
Adj R2	0.603	0.603	0.602	0.604

Notes : The Dependent variable is natural log of price index in NK's exports to China. Sanction from Japan, South Korea, UN is dummy variable having value 1 if year>=2003, year>=2011, year>=2017, repectively. Standard errors are calculated based on clustering at the sector level. *, **, *** indicates statistical significance at the 10%, 5%, 1% level, respectively. All regressions are weighted by the industry's average trade volume between NK and China in the sample period.

Figure 7 displays the results from applying EM-P-Q decomposition to North Korea's major exporting industries. It suggests that the price impacts of sanctions from Japan on North Korea's export to China are largest in textile processing industry, which is one of the main exports of North Korea to Japan and South Korea before imposing sanctions and produced low-skilled labor and does not require large-scale capital or high-skilled labor. This is consistent with our regression results that industries with low capital and human capital intensity and industries that have been exported mainly to the sanction imposing countries are affected more than the others.

Figure II-7. Decomposing North Korea's Export to China by Industry



Notes. This figure displays decomposition results of North Korea's Export to China by broad specification of industry. I categorize North Korea's export products to China by 5 industries: Mining (HS 25~27), agriculture (HS 02~13, HS 17~24), fish (HS 03, 1603~1605), textile (HS 14, 42~43, 50~67) and metal (HS 72~83).

3.4. Robustness Check

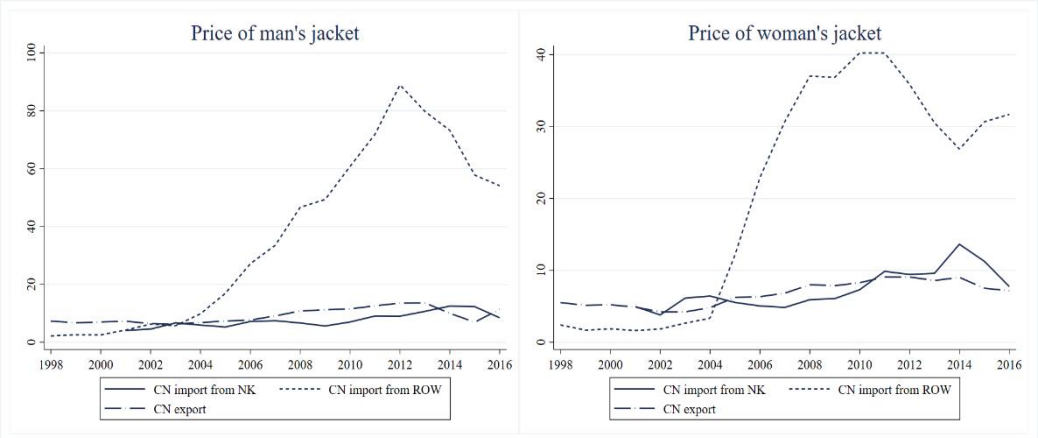
In this subsection, we check whether the sanction effects on relative price index are driven by a single industry.

North Korea's clothing export to China exhibits grate gap in price with that of ROW since mid-2000s. Decreasing relative export prices of North Korea's garment products may be related to the trade modes. North Korea exports apparels to China mostly by processing trade or bonded trade presumed to be re-exported to third countries (Lee, 2005; Jung, 2016; Choi et al., 2016). As seen in Figure 8, China's import prices of apparels surged due to the rising demand for high-end items from income growth while export prices remain low for the last two decades. North Korea is likely to export apparels to China at the low and stable prices to meet the re-export prices of China.[27] As such, the relative price of exports in the clothing industry can be

[27] The export prices of North Korea are possibly linked to those of China, particularly those of Liaoning, where most of Chinese firms that order subcontracting operation to North Korea and the warehouse

very different from that in other industries. Thus, if the baseline results of the price index are driven by the clothing industry, it is risky to interpret it as average effects of sanctions.

Figure II-8. China's Export and Import Prices of Apparels



Notes. The price data is obtained from UN Comtrade database. The left panel and the right panel displays China's export and import price of *Men's or boys' suits, ensembles, jackets, blazers, trousers, bib and brace overalls, breeches and shorts of synthetic fibers (HS 620333),* and *Women's or girls' suits, ensembles, jackets, blazers, dresses, skirts, divided skirts, trousers, bib and breaces overalls, breeches and shorts of*

In this regard, we re-examine the price impacts of sanctions excluding clothing industry (HS 61~62) in Table 8. Column (1) and (2) of Table 8 show that Japanese sanctions have a negative impact on North Korea's relative export prices to China even with the exclusion of clothing industry, implying that the baseline results are not attributed to the price gap in Chinese export and import of apparels. Column (3) ~ (6) also support the bargaining power hypothesis, displaying the coefficients of Japanese sanctions only significant in item groups where North Korea' exports were highly dependent on Japan.

that re-export North Korean products to third countries are located (Kim and Jung, 2015; Choi et al., 2016).

Table Ⅱ-8. Sensitivity Check: Exclude Clothing Industry

Dependent variable : Log of price index	All		Share JP < 10%		Share JP >= 10%	
	FE	Sys GMM	FE	Sys GMM	FE	Sys GMM
Log of lagged price index	0.489***	0.683***	0.334***	0.463***	0.548***	0.764***
	[0.051]	[0.079]	[0.055]	[0.106]	[0.067]	[0.130]
Sanction from Japan	-0.134**	-0.136**	-0.075	-0.029	-0.151**	-0.179**
	[0.054]	[0.051]	[0.080]	[0.147]	[0.063]	[0.063]
Sanction from South Korea	0.024	0.043	0.083	0.028	0.020	-0.007
	[0.032]	[0.040]	[0.064]	[0.063]	[0.032]	[0.051]
Sanction from UN	-0.061	-0.101	0.010	0.004	-0.061	-0.047
	[0.066]	[0.100]	[0.078]	[0.131]	[0.085]	[0.150]
Log of imported value of China	0.015	0.010	-0.032	-0.030*	0.013	0.022
	[0.019]	[0.011]	[0.036]	[0.015]	[0.023]	[0.025]
Log of exported value of NK	-0.004	-0.003	0.007	0.009	-0.006	-0.012
	[0.004]	[0.007]	[0.005]	[0.017]	[0.005]	[0.021]
Coal Price shock	0.076	0.040	-0.063	-0.093	0.105	0.109
	[0.056]	[0.084]	[0.047]	[0.062]	[0.064]	[0.103]
Observations	685	685	412	412	273	273
Number of item groups	52	52	34	34	18	18
Adj R2	0.282		0.142		0.368	
Hansen test		0.224		0.192		0.389
Arellano-Bond AR(2) test		0.790		0.671		0.871

Notes : The Dependent variable is natural log of price index in NK's exports to China. Sanction from Japan, South Korea, UN is dummy variable having value 1 if year>=2003, year>=2011, year>=2017, repectively. Standard errors are calculated based on clustering at the industry level for POLS and FE regression and Windmeijer's finite-sample correction for system GMM. *, **, *** indicates statistical significance at the 10%, 5%, 1% level, respectively. All regressions are weighted by the industry's average trade volume between NK and China in the sample period.

4. Conclusion

This chapter proposes a new approach to assess the recent trend of North Korea's foreign trade by decomposing it into extensive margin, relative price and quantity. The decomposition result shows that the growth of North Korea's export to China is mostly attributed to the quantity growth rather than the extensive margin of the products or improvements in relative prices. Although North Korea's foreign trade has been growing rapidly over the last two decades, the growth is limited to quantity. Rather, the qualitative aspects appear to be declined substantially over the same periods.

Furthermore, this study revisits the sanction effects on North Korea, focusing on the quality of trade. The panel regression results suggest that international economic sanctions induce the qualitative decline by narrowing product diversity and lowering the relative prices of North Korea's export. We also show that one of the underlying channel through which the sanctions reduce relative price of North Korea's exports is disadvantages in bargaining power of North Korea over China.

Since previous studies on North Korean economy mostly focused on the trade volume, the findings of this study are expected to expand our understandings of the North Korea's foreign trade. This study also can contribute to literature on economic sanctions by providing evidence on relationship between sanctions and trade quality.

Chapter 3. The Role of Chinese firms in Bypassing Sanctions on North Korea

1. Introduction

This chapter addresses the reaction of North Korea-China trade to economic sanctions on North Korea, particularly focusing on the role of Chinese trading firms in diluting the effectiveness of the sanctions.

Since the 2000s, North Korea has been under strengthening economic sanctions as a result of a series of their provocative actions, such as military attack, abduction and development of nuclear weapons.

However, most of the early sanctions on North Korea seem to have had a very limited impact on the North Korean economy (Mimura, 2005; Lee and Kim, 2011; Lee and Lee, 2012). For example, UNSC resolutions against North Korea's 1st and 2nd nuclear test (UNSCR 1718, 1917) are limited to North Korea's imports of luxurious goods or items that could be converted for military purposes and have little effects on the overall trade (Noland, 2008; Haggard and Noland, 2010; Jeong and Bang, 2011; 2017) [28]. Unilateral trade sanctions imposed by Japan and South Korea also appeared to be ineffective because North Korea's trade with China has increased rapidly enough to compensate the loss from suspension of trade with the sanction-imposing countries (See Chapter 2-1.).

There has been suspicion that China provide a bypass of sanctions by re-exporting the products of North Korea to the other countries. For example, Jung (2016) shows

[28] On the other hand, the UN Security Council resolutions since 2017 are believed to significantly reduce North Korea's hard currency revenue by placing a complete embargo on North Korea's major exports, tightening inspection on shipments, and repatriating North Korean workers abroad (UNSCR 2375, 2397).

that bonded trade in NK's export to China, by which exports only pass through China to a third country without tariff, increased after the unilateral sanctions from South Korea.[29] Similarly, Choi et al. (2016) also shows that China's re-exports of North Korea's garments to South Korea increased after the sanctions, which accounts 70% of decrease in Inter-Korean direct trade of the same items.

Although the previous studies provide evidence of the existence of the sanction-bypassing trade between North Korea and China, they have limitations in measuring the magnitude. Since the authors only focus on the bonded trade when measuring North Korea's export to third countries transferred in Chinese customs, there is possibility of systemic underestimation if Chinese firms import and re-export products from North Korea under the other trade regimes. The magnitude also can be overestimated when North Korea's export to China and China's export to the sanctions imposing countries exhibit similar trends by chance. Furthermore, the analyses may fail to make a causal inference on the sanction effects because they exploit variations only at a gross level or at a product family level.[30] In this regards, more disaggregated-level data is needed to understand how much the re-export has compensated the loss from trade sanctions.

This article presents a novel evidence of the sanction-bypassing activities in North Korea-China trade, focusing on the effects of South Korean sanctions on North Korea, "May 24th measures". Unlike the existing studies, I employ firm-product level variations in China's trade with North Korea and the other partners including South Korea. The data I use offers detailed information about Chinese firms' imports and

[29] Chinese customs classify transactions into 18 different regimes which vary in their tariff levels (Wang et al., 2012). Studies in China's trade with North Korea rely on more aggregated classifications. Lee (2006) and Choi (2007) categorize transaction between North Korea and China into 6 regimes, "ordinary trade", "border trade", "processing trade", "bonded trade", "international aid", and "others". While, Jung (2016) put "ordinary trade" and "border trade" together to define "general trade".

[30] This study uses the term 'product family' related to more aggregated level classification of trading items. For the Harmonized System classification, the term is used for HS 2-digit or 4-digit classifications.

exports by product and origin/destination countries. To the best of the author's knowledge, this is the most disaggregated level analysis assessing sanction effects on North Korean economy. Also, this is the first study on North Korea-China trade that employs administrative data on firm's trade.[31] Thus, this article contributes to the literature by estimating the effectiveness of sanctions against North Korea more clearly, and extends the understanding of North Korea-China trade by taking the role of involved Chinese firms into account.

In this study, I address two main questions on Chinese firms engaged in trade with North Korea. First, I examine whether Chinese firms re-export products of North Korea to South Korea and If so, to what extent. Second, I investigate the causal effects of South Korean sanctions on the inter-Korean indirect trade through Chinese firms using difference-in-difference setting. The firm-product level analysis has an advantage in mitigating the overestimation problem because one can only consider firms that import a product from North Korea and exports the same product to South Korea. In addition, the effects can be estimated with the control of a firm level characteristics, such as location, ownership type and size.

The empirical results suggest that North Korea has exported to South Korea with Chinese firms' intermediation since the 2000s. The main items in the inter-Korean indirect trade are fishery products and textile products. I also find that South Korean sanctions, "May 24th measure", causes an increase of NK's indirect export of textile products to South Korea transferred by Chinese firms. The magnitude of the effects is also sizable, accounting for 25% of decrease in NK's direct export to South Korea.

The rest of this chapter is organized as follows. Section 2 introduces and describes data used in the chapter and displays stylized facts of firms trading with North Korea.

[31] There are a few existing studies on North Korea's trade conduct firm-level analysis. Kim and Jung (2018) surveys 138 Chinese firms located in Dandong to study the relationship between political ties with North Korean government and firm performance. Haggard and Noland (2018) investigate the role of informal network in resolving dispute by surveying 250 cross-border businesses.

Section 3 discuss empirical models and Section 4 presents main results. The final section concludes with summarizing the findings and discuss their implications.

2. Data

2.1. Chinese Custom Trade data

This study employs administrative database on Chinese firms that participated in international trade over the period 2001~2006 and 2011. The data are collected and released by Chinese Customs offices and provide detailed information about transactions in Chinese import and export. They report firms' free-on-board export and import value in U.S. dollars by product, classified by the Harmonized System (HS) disaggregated at the eight-digit level, and trade partner for 243 source/destination countries. The quantities are recorded in one of 12 difference measurement of unit (such as kilogram, cubic meter), from which the unit prices of transactions are derived.

To exploit firm-product level variations, I reconstruct dataset by aggregating the original data which are recorded at the transaction level. As a result of the aggregation, the dataset contains the following variables. First, each firm-product observation has import/export value and quantity. It also includes the average price defined as value over quantity. Second, I further aggregate the data to generate firm level variables; a firm's total import and export value, the number of destination/source countries a firm trade with, the number of products a firm imports or exports. Third, I extract the information about firm level or firm-product level trade with specific countries, North Korea, South Korea, the U.S., Japan, the EU, which are selected according to the importance in the context of sanctions. While the data are recorded at a monthly frequency, I aggregate it to annual trade flows to smooth out high-frequency variation from seasonality or lumpy contracts. Table III-1 provides the overview of the dataset.

We can also observe some general information about the firms from the data. Each firm is assigned one of eight possible type of ownership structure, such as state ownership, private ownership, joint ventures.[32] A firm's location can be identified at the county level from the first 4-digit of ID number and postal code number. Some trading companies in China are wholesalers that do not engage in manufacturing but intermediate trade between domestic producers and foreign buyers or domestic importers and foreign suppliers. Following previous practices in the literature, I identify such pure trading companies based on keywords that have the meaning of "import," "export", or "international trade" in the company name. (Manova and Zhang, 2008; Ahn et al., 2012)

The data contain additional transaction level details that I do not use in this paper. I observe the customs office where the transaction was recorded, transportation type (such as air, land, ship), custom regimes (out of 18 different regimes such as processing trade, border trade) and any potential transfer country (the origin/destination country in the case of direct trade).

[32] I group the eight types into three categories; state ownership, private ownership and foreigner ownership.

Table Ⅲ-1. Overview of the Dataset

Panel A : overall trade of China

		2001	2002	2003	2004	2005*	2006	2011*	Total
# of firms	Export	68,112	75,609	90,634	110,013	115,767	159,269	245,644	372,183
	Import	66,760	73,872	83,057	93,151	89,306	113,690	148,254	275,342
	Total	88,619	98,264	115,016	136,650	138,715	190,078	298,269	459,301
#of products	Export	6,713	6,884	7,009	7,014	7,090	7,169	6,837	
	Import	6,741	6,877	6,979	6,987	6,985	7,106	6,825	
# of firm-products observations	Export	987,481	1,182,936	1,457,681	1,752,391	1,749,837	2,781,437	3,770,254	
	Import	1,298,838	1,463,294	1,607,572	1,736,040	1,533,357	1,859,197	2,040,174	
Total trade volume (million USD)	Export	289,100	324,300	436,800	585,700	654,300	960,500	1,528,000	
	Import	260,900	290,500	409,800	552,700	510,800	784,400	958,000	

Panel B : trade with North Korea

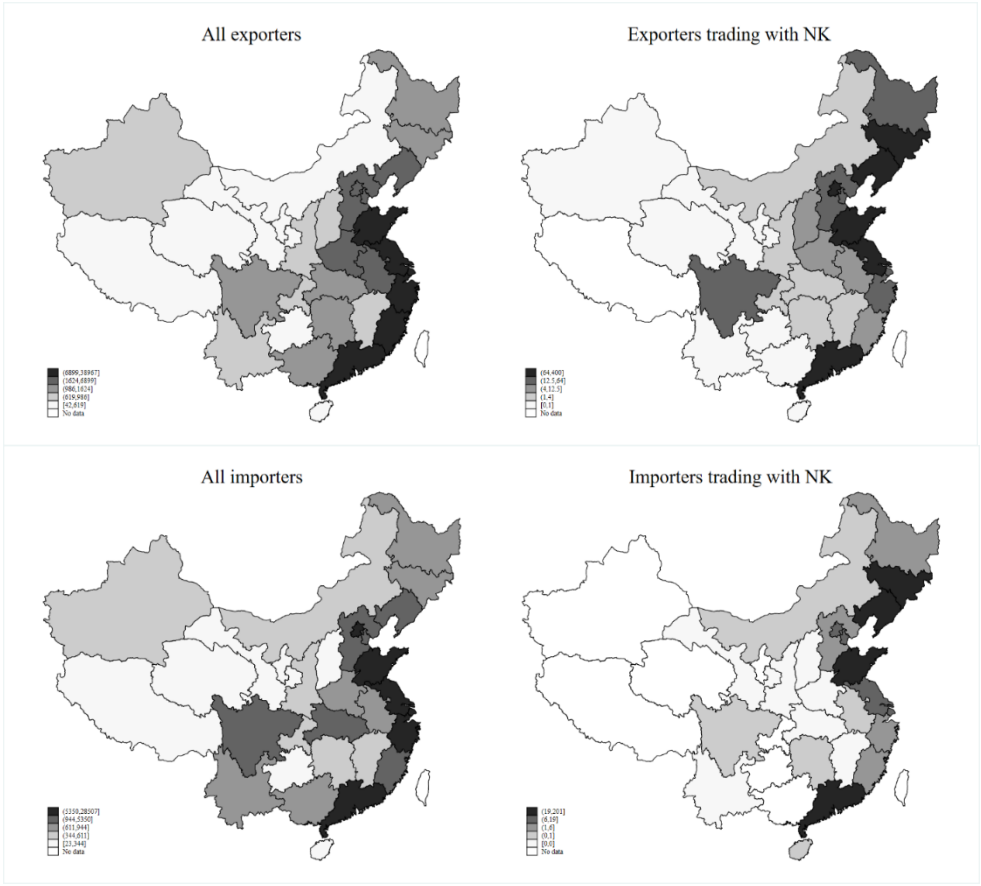
		2001	2002	2003	2004	2005	2006	2011	Total
# of firms	Export	772	803	851	880	934	1,440	1,738	4,639
	Import	216	272	264	386	372	521	777	1,747
	Total	856	916	952	1,084	1,136	1,715	2,134	5,554
#of products	Export	2,474	2,631	2,819	3,072	3,349	3,634	3,696	
	Import	305	463	409	461	451	508	530	
# of firm-products observations	Export	11,280	11,574	12,483	18,356	24,503	42,554	67,216	
	Import	1,018	1,512	1,536	1,981	1,823	2,560	3,262	
Total trade volume (million USD)	Export	602	463	627	765	906	1,220	2,759	
	Import	175	270	382	502	334	451	2,096	

Notes: Some of observations in 2005 and 2011 dataset are omitted because of missing information on flow code and firm identification, respectively.

2.2. Stylized Facts

In this subsection, I present some stylized facts on the Chinese enterprises involved in trade with North Korea. As seen in Table III-1, there are total 4,639 out of 372,183 exporters and 1,747 out of 275,342 importers that experience business with involvement of North Korea. The number of firm-products observations of China's import from North Korea is much smaller than that of export to North Korea, suggesting that firms that import from North Korea are specialized in some items while exporting firms are generalist that deal with broad set of products.

Figure III-1. Spatial Distribution of Chinese Trading Firms



Source : China Custom Trade Statistics 2006

Figure III-1 displays spatial distribution of Chinese exporters and importers by involvement in trade with North Korea. China's trading companies are densely distributed along the southeast coast and around the major manufacturing or consumer areas such as Beijing, Shanghai. In contrast, firms trading with North Korea are concentrated in the Northeast provinces, Liaoning and Jilin, and Shandong that facing the Yellow Sea.

I examine the geography and the subject of North Korea-related businesses employing logit regression model in Table III-2. The first row of Table III-2 confirms the high-density of North Korea-related businesses in the Northeast provinces. The second row shows that firms that located in the cities bordering North Korea have an additional probability of trading. On the other hands, the dummy variable that indicates locating in port city facing the Yellow Sea is only significant in importing from North Korea. In terms of ownership structure, state-owned enterprises are more likely to do business with North Korea than the private-owned, and foreign-owned enterprises are the least likely. Moreover, pure trading companies non-involved in manufacturing are more likely to trade with North Korea.[33]

Next, in Table III-3, I investigate the relationship between trade with North Korea and size of companies with the controls for location and company type. Since we do not observe typical measure of firm size, such as asset or sales revenue, total trade volume is used as proxy. The results show that firms with larger export revenue (import expenditure) have grater probability of export to (import from) North Korea. I also examine correlation between trading with North Korea and firms' extensive margin in terms of items and partners. It is found that firms selling more items to more destinations are more likely to enter the North Korean import market. For importers, no such correlation exists.

[33] For more details on the distribution of companies by region, ownership structure, and participation in production, see Appendix 3.1.

Table Ⅲ-2.Stylized Facts 1 : Location and Company Type

Dep. Variable : 1(trade with North Korea>0)	Importing firms				Exporting firms			
	All periods	2001~2003	2004~2006	2011	All periods	2001~2003	2004~2006	2011
Location								
Three Northeast provinces	2.327***	2.553***	2.270***	2.235***	2.157***	2.154***	2.012***	2.494***
	[39.28]	[24.40]	[24.65]	[18.54]	[65.53]	[41.29]	[40.45]	[31.72]
City bordering North Korea	3.682***	3.640***	3.908***	3.327***	2.649***	2.422***	2.788***	2.641***
	[51.96]	[31.46]	[35.20]	[21.60]	[58.30]	[32.11]	[41.30]	[25.33]
Port city on the east coast	0.368***	0.203	0.624***	0.131	-0.048	0.035	-0.033	-0.265**
	[5.92]	[1.68]	[6.63]	[1.10]	[-1.30]	[0.57]	[-0.60]	[-3.05]
Company type (ref : private company)								
Foreign-invested company	-1.179***	-1.131***	-1.339***	-0.765***	-1.110***	-1.051***	-1.172***	-0.939***
	[-18.84]	[-8.96]	[-15.60]	[-6.25]	[-26.32]	[-13.82]	[-20.10]	[-8.51]
State-owned company	0.518***	0.674***	0.337***	0.578***	0.930***	1.069***	0.807***	1.058***
	[9.56]	[6.33]	[4.47]	[4.01]	[29.59]	[18.19]	[18.86]	[11.61]
Trade mode (ref : manufacturer)								
Pure trade company	0.850***	1.112***	0.762***	0.728***	0.924***	0.882***	0.879***	1.039***
	[18.99]	[12.40]	[11.15]	[9.01]	[35.05]	[18.56]	[21.90]	[19.91]
Time fixed effects	Y	Y	Y	N	Y	Y	Y	N
Number of observations	668,090	223,689	296,147	148,254	865,048	234,355	385,049	245,644
Pseudo R2	0.333	0.404	0.362	0.213	0.233	0.263	0.233	0.193

Notes : The table contains results from Maximum Likelihood Estimation on Logit regression model. The figures in the brackets are Z-statistics calculated based on robust standard erros. *, **, *** indicates statistical significance at the 5%, 1%, 0.1% level, respectively. The dependent variable is dummy variable that takes value 1 if a firm imports positive value from North Korea for column (1) ~ (4), and that takes value 1 if a firm exports positive value to North Korea for column (5)~(8).
All columns except for column (4) and (8) include year fixed effects.

Table Ⅲ-3. Stylized Facts 2: Size and Diversfication

Dep. Variable : 1(trade with North Korea>0)	Importing firms				Exporting firms			
	All periods	2001~2003	2004~2006	2011	All periods	2001~2003	2004~2006	2011
Log import(export) volume	0.301***	0.250***	0.313***	0.327***	0.104***	0.169***	0.077***	0.106***
	[26.29]	[10.85]	[18.68]	[15.67]	[10.58]	[9.68]	[5.15]	[5.20]
Log # of imporing(exporting) products	-0.048*	0.013	-0.103***	0.005	0.524***	0.270***	0.541***	0.805***
	[-2.38]	[0.31]	[-3.52]	[0.12]	[36.41]	[11.18]	[26.20]	[24.24]
Log # of source(destination) countries	0.123***	0.112	0.146**	0.065	0.125***	0.210***	0.122***	-0.013
	[3.38]	[1.48]	[2.73]	[1.00]	[8.44]	[7.57]	[5.59]	[-0.43]
City bordering NK	3.434***	3.394***	3.393***	3.519***	2.655***	2.326***	2.608***	3.223***
	[50.08]	[26.02]	[33.50]	[24.96]	[56.26]	[27.52]	[37.40]	[31.28]
Foreign-invested company	-1.454***	-1.504***	-1.607***	-0.900***	-1.085***	-1.369***	-1.087***	-0.775***
	[-20.97]	[-10.91]	[-16.90]	[-6.77]	[-24.18]	[-16.70]	[-17.58]	[-6.60]
State-owned Company	-0.005	0.300**	-0.272**	0.007	0.271***	0.287***	0.262***	0.311**
	[-0.09]	[2.61]	[-3.28]	[0.05]	[7.90]	[4.35]	[5.67]	[3.19]
Pure trade Company	0.869***	0.914***	0.761***	0.973***	0.221***	0.228***	0.182***	0.267***
	[17.55]	[9.21]	[10.27]	[10.64]	[7.41]	[4.00]	[4.03]	[4.33]
Province fixed effects	Y	Y	Y	Y	Y	Y	Y	Y
Time fixed effects	Y	Y	Y	N	Y	Y	Y	N
Number of Observations	639,175	214,647	287,406	124,151	822,149	234,248	382,574	202,335
Pseudo R2	0.403	0.451	0.423	0.319	0.317	0.342	0.319	0.315

Notes : The table contains results from Maximum Likelihood Estimation on Logit regression model. The figures in the brackets are Z-statistics calculated based on robust standard erros. *, **, *** indicates statistical significance at the 5%, 1%, 0.1% level, respectively. The dependent variable is dummy variable that takes value 1 if a firm imports positive value from North Korea for column (1) ~ (4), and that takes value 1 if a firm exports positive value to North Korea for column (5)~(8). All columns include province fixed effects, thus some observations are dropped due to the perfect prediction. All except for column (4) and (8) include year fixed effects.

3. Empirical Strategy

The main goals of this article are (i) to find evidence of local network that North Korea's products are exported to third countries, especially South Korea, with Chinese firms as intermediaries and (ii) to estimate the effects of South Korean sanctions on the size of the indirect trade. The former can be characterized as the following equation;

$$Pr(ImpNK_{fp} > 0) = F(a + \beta * \boldsymbol{dExp_{fp}} + C_f'\gamma + S_{fp}'\varphi + \delta_p) \quad (3\text{-}1)$$

where $ImpNK_{fp}$ is firm f's import volume of product p from North Korea, and $dExp_{fp}$ is a dummy variable that have value 1 if firm f exports positive value of product p to any destination. C_f is the vector of control variables for firms' general status, such as location and ownership type, and S_{fp}' denotes a set of firm-product level covariates including total trade volume and average relative price. I also include the product fixed effects, δ_p, thus the coefficients of interest β is interpreted as within-product estimator.

Then, I extend the model to identify the main destinations of the indirect exports of North Korea;

$$Pr(ImpNK_{fp} > 0) = F(a + \beta_1 * \boldsymbol{dExp_{fp}} + \beta_2 * \boldsymbol{dExpSK}_{fp} + \beta_3 * \boldsymbol{dExpJP}_{fp} + \beta_4 * \boldsymbol{dExpUS}_{fp} + \beta_5 * \boldsymbol{dExpEU}_{fp} + C_f'\gamma + S_{fp}'\varphi + \delta_p) \quad (3\text{-}2)$$

where $dExpSK_{fp}$, $dExpJP_{fp}$, $dExpUS_{fp}$ and $dExpEU_{fp}$ denotes firm-product level indicator variable of export to South Korea, Japan, the United State and European countries, respectively. Since the dependent variable is binary, the logit regression model is utilized for baseline results, which is complemented with linear probability model for the size of the effects.[34]

[34] For the results of linear probability model, see Appendix3-2.

Finally, I set the following difference-in-difference style regression equation to investigate the effects of South Korea sanctions (5.24 measure) on Chinese firms' re-exports of North Korean products;

$$Log(ExpSK_{fpt}) = a + \boldsymbol{\beta_1} * \boldsymbol{dImpNK_{fpt}} + \boldsymbol{\beta_2} * \boldsymbol{dImpNK_{fpt}} * \boldsymbol{Post_t} + C'_{ft}\gamma + S'_{fpt}\varphi + \delta_{pt} + \varepsilon_{fpt} \qquad (3\text{-}3)$$

The dependent variable, $ExpSK_{fpt}$, denotes firm f's export volume of product p to South Korea at time t, and $dImpNK_{fpt}$ is the key indicator of treatment group that have value 1 if firm f imports positive value of product p to from North Korea. The subscript t is a time indicator and $\boldsymbol{Post_t}$ is the sanction dummy that captures the intervention of South Korean sanctions. I only use observations of year 2006 and 2011 in this regression, thus $\boldsymbol{Post_t}$ have value 1 for year 2011 and 0 for 2006.[35] The product-time fixed effect δ_{pt} is included to control unobservable characteristics of product and time-specific common factors that can affect firms' trade volume.

Equation (3-3) is set to compare the changes in export volume to South Korea, in response to "5.24 measure", between the group of observations that have positive import from North Korea (treatment group) and those that have nothing to import from North Korea (reference group). It presumes that the geopolitics between South and North Korea doesn't directly affect South Korea-China trade.

4. Regression Results

4.1. North Korea's Indirect Exports via China

Table III-4 provides evidence of the indirect export of North Korea with Chinese firms

[35] Since I cannot access the database over the period 2007~2010, the difference-in-difference estimators may fail to capture the pure causal effects of the South Korean sanctions if there are another factors that induce structural changes in North Korea-China trade. I check this possibility with the product level dataset in the next section.

as intermediaries. Column (1)~(3), (4)~(6) and (7)~(9) presents the regression results from the wave 2002, 2006 and 2011, respectively.[36]

Column (1), (4) and (7) estimate the baseline model (3-1), and show that, within a given product, firms importing the item from North Korea are also likely to be exporters of the item. The linear probability model predicts that exporting firms have 0.9% points grater probability of importing the same products from North Korea in 2006 (See Table A3-3).

Column (2), (5) and (8) presents the estimation results of the extended model with inclusion of $dExpSK_{fp}$ and $dExpJP_{fp}$. It is found that firms exporting a product to South Korea have additional 5.6% point in probability to import the product from North Korea in 2006. On the contrary, exporting to Japan reduces the probability by 1% point. From these results, I suggest that the main destination of the indirect exports of North Korea is South Korea. Column (3), (6) and (9) also include dummy variables for export to the US and the EU. The estimates for the dummies are not statistically significant and the inclusion of them do not change the other coefficients substantially.

Table III-5 separates sample into subgroups by three major exporting industry of North Korea and estimates equation (3-2) again within subgroups. The results suggest that the main items North Korea indirectly exports through Chinese companies are fishery and textile products. Specifically, fishery products and textile products are mainly re-exported to South Korea in the 2000s and in the early 2010s, respectively. The linear probability model predicts that firms exporting a textile product to South Korea have about 18% points grater probability of importing the same product from North Korea than those non-involved in export in 2011. The results are in line with previous studies using aggregated data or interviews with businessperson (Lee, 2006; Choi, 2007; Joung, 2015).

36 In this regression, I consider the observations in 2002, 2006 and 2011 are representatives of those of early-2000s, mid-2000s and early-2010s, respectively.

Table Ⅲ-4. Evidence of North Korea's Indirect Export through Chinese Firms

Dep. Variable : **1**(Import from North Korea>0)	Year : 2002			Year : 2006			Year : 2011		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Export dummy	1.497*** [11.56]	0.917*** [5.27]	0.905*** [5.12]	1.488*** [11.77]	1.280*** [8.54]	1.286*** [8.45]	1.541*** [18.67]	1.316*** [14.18]	1.326*** [13.78]
Export to South Korea dummy		1.836*** [9.33]	1.856*** [9.39]		0.983*** [5.79]	0.985*** [5.78]		1.152*** [12.50]	1.151*** [12.40]
Export to Japan dummy		-0.712*** [-3.33]	-0.702** [-3.21]		-0.315 [-1.81]	-0.307 [-1.73]		-0.556*** [-5.16]	-0.544*** [-4.96]
Export to US dummy			-0.483 [-1.43]			-0.037 [-0.15]			-0.069 [-0.55]
Export to EU dummy			0.381 [1.40]			-0.026 [-0.12]			-0.010 [-0.09]
Log of import value	0.210*** [9.39]	0.200*** [8.72]	0.200*** [8.72]	0.232*** [11.00]	0.216*** [10.12]	0.217*** [10.11]	0.368*** [25.98]	0.349*** [24.00]	0.349*** [23.97]
Log of import price	-0.230*** [-5.43]	-0.222*** [-5.14]	-0.224*** [-5.17]	-0.514*** [-11.97]	-0.487*** [-11.32]	-0.487*** [-11.31]	-0.413*** [-16.49]	-0.370*** [-14.58]	-0.371*** [-14.59]
Product fixed effects	Y	Y	Y	Y	Y	Y	Y	Y	Y
Company type dummy	Y	Y	Y	Y	Y	Y	Y	Y	Y
Province dummy	Y	Y	Y	Y	Y	Y	Y	Y	Y
Number of Observations	208,780	208,780	208,780	264,398	264,398	264,398	417,174	417,174	417,174
Number of Products	449	449	449	476	476	476	477	477	477
Pseudo R2	0.697	0.71	0.71	0.783	0.786	0.786	0.62	0.63	0.63

Notes : This table examines the relationship between firms'import from North Korea and exports to the other countries, using cross-firm variations within product. The outcome variable is a binary response that have value 1 if a firm import positive value of a product from North Korea. The coefficients are estimated based on Logit regression model . The figures in the brackets are Z-statistics calculated based on robust standard erros. Column (1)~(3), (4)~(6) and (7)~(9) presents regression result in 2002, 2006 and 2011, respectively. All columns include product fixed effects, province fixed effects and company type dummy. *, **, *** indicates statistical significance at the 5%, 1%, 0.1% level, respectively.

Table Ⅲ- 5. Evidence of North Korea's Indirect Export through Chinese Firms: by Industry

Dep. Variable : 1(Import from North Korea>0)	Mining			Textile			Fish		
	2002	2006	2011	2002	2006	2011	2002	2006	2011
Export dummy	0.677	1.976	1.752*	3.378**	1.179**	1.616***	0.846	1.726***	0.866
	[0.86]	[1.76]	[2.15]	[2.63]	[2.61]	[9.88]	[0.91]	[3.42]	[1.21]
Export to South Korea dummy	-0.039	1.972	0.987	1.878	0.257	0.861***	2.680***	1.220*	-0.069
	[-0.03]	[1.52]	[0.92]	[1.66]	[0.59]	[6.55]	[3.84]	[2.13]	[-0.10]
Export to Japan dummy	0.411	-1.542	-1.801	-2.494**	0.066	-0.281	0.696	-1.223*	-0.696
	[0.39]	[-1.02]	[-1.84]	[-3.24]	[0.17]	[-1.95]	[0.92]	[-2.28]	[-1.04]
Log of import value	-0.136	-0.126*	0.197***	0.938***	0.766***	0.608***	-0.059	-0.156*	0.422**
	[-1.43]	[-2.51]	[3.74]	[5.51]	[9.70]	[21.75]	[-0.58]	[-2.25]	[2.60]
Log of import price	-1.961***	-0.744***	-0.192***	-0.656**	-0.816***	-0.734***	0.249	-0.144	-0.472
	[-5.43]	[-3.96]	[-4.09]	[-2.68]	[-5.85]	[-13.26]	[1.17]	[-0.89]	[-1.30]
Product fixed effects	Y	Y	Y	Y	Y	Y	Y	Y	Y
Company type dummy	Y	Y	Y	Y	Y	Y	Y	Y	Y
Province dummy	Y	Y	Y	Y	Y	Y	Y	Y	Y
Number of Observations	3,194	3,503	3,565	16,497	26,160	30,762	1,303	1,808	519
Number of Products	38	43	36	93	117	141	35	35	14
Pseudo R2	0.849	0.834	0.766	0.965	0.941	0.777	0.841	0.747	0.673

Notes : This table examines the relationship between firms'import from North Korea and exports to the other countries by industy. The outcome variable is a binary response that have value 1 if a firm import positive value of a product from North Korea. The coefficients are estimated based on Logit regression model . The figures in the brackets are Z-statistics calculated based on robust standard erros. Column (1)~(3), (4)~(6) and (7)~(9) presents regression result from the sample restricted to mining industry, textile industry and fishing industry respectively. All columns include product fixed effects, province fixed effects and company type dummy. *, **, *** indicates statistical significance at the 5%, 1%, 0.1% level, respectively.

4.2. The Effect of Sanctions on the Indirect Exports

In Table III-6, I examine the impact of South Korea's sanctions on the indirect exports of North Korea. The difference-in-difference coefficient in column (1) indicates that May 24th measures significantly increase North Korea's indirect export to South Korea. Column (2)~(8) estimate differential effects of the sanctions by industry subgroups. It is found that May 24th measures only have a significant impact on the re-export of textile products. Specifically, they increase NK's indirect exports of textile products to South Korea through Chinese firms by 21 log points. The magnitude of the effects can be translated into 38 million U.S. dollars, which accounts for 25% of decrease in North Korea's direct export to South Korea after the sanctions.

The estimates are much lower than those of the previous studies such as Choi et al. (2016) which reports the re-exports of North Korea's apparels to South Korea through Chinese custom increased by 100million USD after the May 24th measure. There are two reasons for the difference. First, the re-exports are identified at more disaggregated level in this study; only when a firm import a product from North Korea and export the same product to South Korea in the same period. Second, I estimate the causal effects of South Korean sanctions by difference-in-difference methods while the previous studies simply present the changes in trade volume.

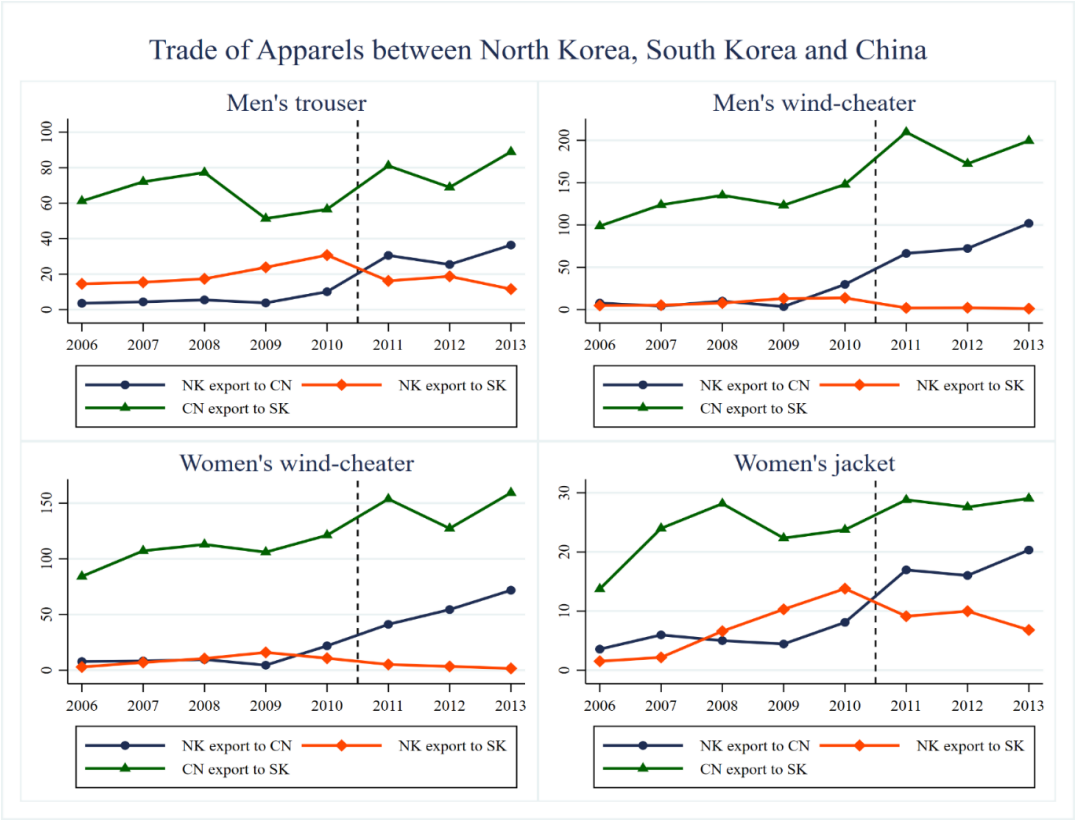
Table Ⅲ-6. The Effects of Sanctions on North Korea's Indirect Export

Dep. Variable : Log of firm-product level export value to South Korea	All products (1)	Mining (2)	Textile (3)	Fish (4)	Agriculture (5)	Metal (6)	Machinery (7)	Others (8)
Import from North Korea dummy (treated)	0.335***	0.438	0.448***	0.166	-0.176	-2.380***	1.677***	-0.289
	[0.096]	[0.905]	[0.099]	[0.525]	[0.239]	[0.800]	[0.561]	[0.492]
Treated * Post	0.298**	0.247	0.208*	0.137	0.545	0.989	-0.896	0.563
	[0.116]	[1.246]	[0.121]	[0.756]	[0.354]	[0.960]	[0.807]	[0.616]
Log of exporting volume by firm	0.143***	0.180*	0.217***	0.150**	0.105**	0.050	0.102***	0.046*
	[0.014]	[0.095]	[0.013]	[0.064]	[0.050]	[0.044]	[0.036]	[0.025]
Log of importing volume by firm	-0.044***	-0.051	-0.054***	-0.032	0.011	-0.118***	-0.052**	-0.016
	[0.006]	[0.039]	[0.005]	[0.032]	[0.027]	[0.017]	[0.022]	[0.016]
Log of importing price by firm and product	0.099***	0.003	0.230***	0.298*	0.135	-0.183***	0.085***	0.075***
	[0.019]	[0.107]	[0.023]	[0.166]	[0.100]	[0.051]	[0.028]	[0.027]
Product-year FE	Y	Y	Y	Y	Y	Y	Y	Y
Company type dummies	Y	Y	Y	Y	Y	Y	Y	Y
Province dummies	Y	Y	Y	Y	Y	Y	Y	Y
Number of observations	84,810	541	55,335	1,029	1,105	3,799	7,805	15,196
Number of products	494	18	217	29	38	33	51	108
R-square	0.214	0.452	0.177	0.192	0.22	0.346	0.101	0.21

Notes : This table examines the existence and magnitude of sanction-detouring by re-export of North Korean products. The dependent variable is natural log of firm-product level export value to South Korea. The coefficients are estimated from OLS regression. The figures in the brackets are robust standard errors clustered at product level. *, **, *** indicates statistical significance at the 10%, 5%, 1% level, respectively. All columns include product fixed effects, province fixed effects and company type dummy.

I then check whether the difference-in-difference estimators capture the effects of South Korea's sanctions imposed in 2010 successfully. As noted previously, the observations over the periods 2007~2010 are not available in this study. So, we cannot sure the difference-in-difference estimators indicate pure causal effects of the South Korean sanctions if there are another factors in the omitted periods that induce structural changes in North Korea-China trade. To reduce these concerns, I present trends of Sino-North Korea, Sino-South Korea and Inter-Korean trade of some major products in textile industry. As shown in Figure III-2, North Korea's direct exports to South Korea dropped while North Korea's exports to China and China's export to South Korea exhibit discontinuous increase between 2010 and 2011. In contrast, there isn't another notable changes in apparels trade of any of three bilateral pairs.

Figure III-2. Effects of South Korean Sanctions on Trade: Product-level evidence



5. Conclusion

The effectiveness of economic sanctions is an essential element in discussing recent trends of North Korean economy as well as international politics around Korean Peninsula. Since 2000s, North Korean economy is subject to measures that regulate financial transactions, freeze foreign asset, and restrict trade flows and human travel. Among them, trade sanctions are considered to be the key measures because they could directly target North Korea's foreign currency revenue and import of items for military use. However, it is not until 2017 that China, the largest trade partner of North Korea, started to participate in the sanctions on North Korea. Moreover, China's trade with North Korea rapidly increased since mid-2000s. Thus, there has been skepticism that North Korea mitigates the economic damage from sanctions successfully with the support of China. In this regard, estimates of the impacts of sanctions on North Korea's trade with China can provide important implications on the receivers' response to sanctions.

Using detailed information about Sino-North Korea trade, this chapter investigates the existence of detour through which North Korea bypass South Korea's trade sanctions in cooperation with China. I employ administrative data that covers the universe of Chinese firms engaged in foreign trade to obtain more reliable estimates. In line with the previous studies, I find the evidence of trilateral trade in which China imports North Korea's fishery and textile products and re-exports them to South Korea. The South Korea's sanctions imposed in May 2010 increased the inter-Korean indirect trade of textile products by 21 log points, which partially substitutes North Korea's direct exports to South Korea.

Despite of increasing intensity of economic sanctions, North Korea has not stopped military provocations and the development of WMD. The findings of this chapter suggest that, without China's participation, the effectiveness of trade sanctions on North Korea can be easily diluted. This reaffirms the previous findings

that emphasize the importance of international cooperation for success of economic sanctions (Martin, 1993; Wallensteen et al., 2003; Lopez and Cortright, 2004; McLean and Whang, 2010). In particular, the results of this chapter provide an implication that the success of economic sanctions depends on the support of the sanctioned country's major trading partners.

Concluding Remarks

This dissertation has investigated economic reactions to geopolitical conflicts with particular considerations on the stock market and foreign trade. Each of the previous three essays focuses on a specific issue related to inter-Korean relations and provides empirical evidence to extend our understandings of the relationship between conflicts and economic outcomes.

Chapter 1 explores the effects of North Korea-related risk on the stock price of South Korean companies. I construct a novel measure for the geopolitical risk associated with inter-Korean relations based on keyword searches on news articles. It is found that increasing geopolitical uncertainty related to North Korea depresses stock returns. The firms with higher irreversibility of assets, larger stake of domestic investors, and involved in Inter-Korean economic cooperation exhibit a more sensitive response to the geopolitical risk. This implies that investment irreversibility and international portfolio diversification are important mechanisms underlying the effects of country-specific geopolitical uncertainty on the stock market.

The last two essays explored structural changes in the Sino-North Korean trade facing the economic sanctions on North Korea. Chapter 2 decomposes North Korea's export to China into the extensive margin, price, and quantity to assess the impacts of economic sanctions focusing on the qualitative aspects of the trade. The empirical results find the adverse effects of sanctions on the quality of North Korea's foreign trade. It is found that the extensive margin of North Korea's export to China is not increased by the trade sanctions from Japan and South Korea and substantially decreased by UNSC resolution in 2017. Moreover, the sanctions are found to create disadvantages in the price setting of North Korea's exports to China. According to the subsample regression results, one of the reasons for the sanctions to discount North Korea's exports is the bargaining power of China over North Korea.

In the final chapter, I exploit firm-product level variations in Chinese trade data to examine whether North Korea circumvents South Korean sanctions by indirectly exporting its products through Chinese firms. The difference-in-difference estimation is conducted to obtain more reliable evidence of the sanction-bypassing trade. I find that transit trade in which Chinese firms import North Korea's fishery and textile products and re-export them to South Korea is significantly increased after South Korea's sanctions. This implies that the effectiveness of economic sanctions can be diluted through a bypass provided by a third country that has close economic relationships with both the sender and the receiver.

The case of Korea can draw attention because of its unique historical background. Since the division and the war, South and North Korea have been hostile to each other militarily, but they have also had a considerable economic engagement. Thus, the geopolitical tension between the two Korea has the potential to have negative economic impacts particularly on the sectors involved in inter-Korean cooperation.

Throughout the three chapters, I presented some empirical evidence supporting this prediction. For South Korea, geopolitical tension with North Korea produces more volatility in the stock market. In particular, firms involved in inter-Korean economic cooperation have disadvantages of not only decreasing stock returns but also losing business with North Korea. North Korea, although it mitigates the damage of sanctions imposed by the neighboring countries such as South Korea and Japan by expanding economic engagement with China, pays implicit costs such as undermined product diversity and unfavorable export prices in foreign trade. The embargo on inter-Korean direct trade has produced additional costs for the trade flows to be transferred by Chinese firms.

On the other hand, China benefits from the geopolitical conflicts between the two Koreas. It has monopolized exports of North Korea that is isolated from the alternative trade partners. The advantage of bargaining power makes China import North Korea's products much cheaper prices than average import prices. Moreover, Chinese firms

have gained rents by brokering trade between the two Koreas since the May 24th measures. This gives us a hint of the reason why it is difficult to resolve conflicts between the two Koreas. Efforts to align incentives of neighboring countries both economically and politically would help ease the geopolitical tension around the Korean Peninsula.

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Appendices

A1. Supplementary Materials for Chapter I

A1.1. Details on Media Sample of GPRNK Index

Before construction of GPRNK index, we performed audit study to identify keywords implying escalation and reduction of geopolitical tension in Korea. Figure A1-1 displays newspaper headlines at the date of major events associated with North Korean threat or Inter-Korean relations.

Our selection of media sample is based on the popularity of the press. Table A1-1 presents the subscription ranking of newspapers in 2012. We include top 10 daily newspaper and top 5 economic magazine in paid subscriber counts except for Chosun Il-bo, Choongang Il-bo and Donga Il-bo who provide search query service using complex command only after 2018.

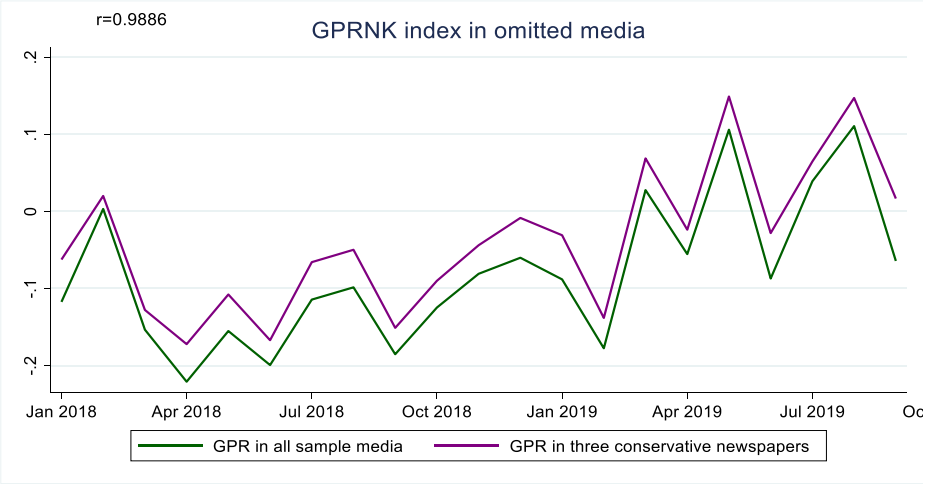
Figure A1-1. Newspaper Headlines on the Dates of Geopolitical Events

Table A-1. Ranking of Korean newspaper by paid subscription

Rank	Title	Copies	Paid copies
1	Chosun Ilbo	1,769,310	1,325,555
2	Choongang Ilbo	1,292,498	916,770
3	Donga Ilbo	1,060,760	753,237
4	Maeil Business	836,316	554,922
5	The Korea Economic daily	517,193	349,765
6	The Farmers Newspaper	306,174	301,123
7	Sports Chosun	304,888	240,606
8	Hankyoreh	269,174	210,098
9	The Daily Sports	263,632	183,409
10	Kyunghyang Shinmun	232,660	176,202
11	Hankook Ilbo	263,718	168,378
12	Kukmin Ilbo	206,035	147,848
13	Sports Seoul	201,145	142,572
14	Sports Donga	191,749	141,543
15	Munhwa Il-bo	174,525	140,359
16	Seoul Shinmun	163,713	110,195
17	Segye Ilbo	85,865	60,529
18	Seoul Economic Daily	85,878	59,838
19	Sports Kyunghyang	79,628	57,846
20	Money Today	84,086	56,771
21	Electronic Times	63,000	51,308
22	Naeil Shinmun	60,849	42,166
23	Herald Business	56,652	36,645
24	The Asia Business Daily	29,578	22,393
25	The Korea Herald	33,039	21,514

As discussed in Section 3.2, the exclusion of three most-read news may cause the downward bias to our measure of geopolitical risk. We simply test the possibility of this selection bias by comparing the index from whole sample and from Chosun, Choong-ang and Dong-a after 2018. Figure A1-2 implies that our measure may be biased to assess the geopolitical tension with North Korea systemically lower than true media attention. However, this is not likely to affect the regression result because the index from three omitted newspaper almost perfectly co-moves with our GPRNK index since 2018.

Figure A1-2. Assessing Possible Measurement Error



A1.2. Additional Robustness Checks

In this appendix section, we discuss additional robustness of the main results of the firm-level panel regression. First, we check the selection issue in economic cooperation. The list of firms on Table A1-2 is collected from Kim and Jung (2014), and those used in Korea Investment Securities Co. Some of these firms seems to be on the list because the stock return soared at the time of great expectation for economic cooperation, which can induce endogeneity problem. Thus, we check this concern by restrict the economic cooperation dummy to those once participated in business with North Korea (bold company name). The result is very similar to the baseline regression of Section 4, although the coefficient of economic cooperation is slightly smaller.

Table A1-2. The list of firms involved in economic cooperation with North Korea

Category	Company Name	Details of Economic Cooperation
Kaesung Industrial Complex	**인디에프**	**개성공단에 입주했던 의류제조업체인 인디에프개성이 계열사**
	재영솔루텍	**개성공단에 입주했던 핸드폰카메라 모듈 및 반도체 검사용 소켓 생산 기업**
	롯데제과	**북한 내 공장 건설 추진, 과거 개성공단 내 납품 점유율 90%**
	태평양물산	**의류 생산 업체, 개성공단 내 2700평 토지이용권 보유**
	케이티	**KT 개성지사를 통해 남북간 민간 통신망 연결 경험, 대북관광, 이산가족 상봉 등 제반 교류협력에 통신서비스 제공**
	신원	**개성공단에 입주했던 의류 제조업체로 의류 OEM수출 및 BESTI BELLI, SI 등 브랜드 사업 영위**
	씨엔플러스	**개성공단에 입주한 계열사 코씨엔의 지분 100%보유, 2012년 12월 60% 매각.**
	좋은사람들	**개성공단에 입주했던 내의류 제조 및 판매 기업으로 보디가드, 예스 등의 브랜드를 보유**
	제이에스티나	**개성공단에 입주했던 손목시계, 주얼리 등 악세서리 제조 기업**
	자화전자	**개성공단 입주 기업, 전자부품 제조업체**
	태광산업	**석유화학, 섬유, 직물 등 섬유 산업을 수직적으로 아우르는 업체, 개성공단 입주기업**
	남광토건	**개성공단에 지사를 설립, 철골공장 및 대북사업 영역 확대를 추진하던 기업으로 토목, 건축, 주택사업 영위**
	인지컨트롤스	**개성공단에 위치한 계열사인 인지개성의 지분 100%를 보유**
Tourism	**아난티**	**골프레저 업체로 금강산 아난티 골프 & 온천 리조트를 보유**
	현대상선	**금강산 크루즈선 관광사업, 현대아산 지분보유, 나진-하산 프로젝트**
	롯데관광개발	현재 속초-블라디보스톡 크루즈 사업 진행 중, 원산-평양 등 대북 크루즈 및 페리 사업 추진 계획
	현대엘리베이터	**현대아산의 지분 67.6%를 보유**
	용평리조트	최대주주인 통일교 재단이 용평리조트를 활용하여 대북 관광사업 진행 기대감
Agricultural Cooperation	남해화학	비료 생산 및 판매업체. 국내 최대의 비료 생산설비 보유
	아세아텍	**농기계 생산업체로 과거 대북지원을 위한 농기계가 구입된 사례가 있음**
	하림	**평양 인근지역에 양돈시설 건립 추진**
	동양물산기업	**농기계 생산업체로 과거 금성뜨락또르공장에 농기계 설비 공급**
	성보화학	작물보호제 생산 전문 기업
	롯데정밀화학	일반화학, 전자재료 등 다양한 화학제품 제조, 비료지원 관련주
	에이스침대	**사리원에 합영회사 설립하기로 하였으나 무산, 재단법인 에이스경암을 통해 대북 영농지원 사업**
	경농	농약 제조 및 판매업체. 종속회사로 비료 생산업체인 조비를 보유하고 있음
	조비	비료 생산업체로 친환경 맞춤비료, 완효성비료, 4종비료 등 다양한 비료를 생산하여 농협 및 대리점을 통해 판매

Table A1-2. The list of firms involved in economic cooperation with North Korea (cont'd)

Aid to North Korea	**한샘**	**가구업체로 각종 대북지원사업 후원 기업**
	녹십자	**의약품 지원 관련 남북경협 관련주. 의약품 제조/판매업체로 각종 혈액제제류와 필수백신(독감, 수두 등)을 생산함**
Electricity Transmission	제룡산업	변압기 제조업체로 주력제품은 고효율에너지 기자재인 아몰퍼스 변압기
	세명전기	송전, 배전 및 변전선로용 금구료 제조 및 판매업체. 최근
	이화전기	무정전 전원장치 및 몰드변압기, 정류기, SCADA, ETUS 신제품과 다양한 전원공급장치 및 전력변환 장치를 생산 공급하는 중전기기 전문회사
	보성파워텍	중전기기류,송배전자재류,철구조물등을 생산하는 기업으로 송전용 철탑, 철구조물이 주 수입원.
	제룡전기	변전・배전 및 철도 기자재를 생산하는 중전기기 전문 제조기업
	비츠로테크	차단기와 개폐기류 등의 전력 부품을 제조하는 기업
	한국전력공사	**남북경협 시 전력 공급 책임, 개성공단에 전력공급 경험**
	가온전선	고압 및 중저압 전력케이블, 데이터 케이블, 광통신케이블 등
	서전기전	배전반, 차단기 공급, 전기공사 업체
	선도전기	중전기기 전문업체로 발전, 송변전, 배전설비등 제반 산업용 플랜트의 전력설비에 공급되는 각종 가스절연개폐기, 차단기, 보호계전기반, 제어시스템 등 제작, 판매
	광명전기	전력 수배전반 업체 중 국내 최초로 ISO9001 품질인증 획득. 2004년 6월 피앤씨테크㈜를 전격 인수해 디지털 계전기류와 전력보호, 자동화설비로 사업영역 확대
	대원전선	전력 및 통신 케이블 제조/판매업체. 주요제품으로 전력 공급 및 정보통신망 구축, 전기전자기기, 자동차, 각종 기계 등에 들어가는 전력 및 통신케이블(광케이블포함) 등을 생산
	비츠로시스	산업설비내 전력장치를 제어하는 장치 제조업체로 비츠로애드 설립을 통해 지하철 정보제공시스템 구축사업에도 진출
	일진전기	초고압 케이블, 변압기 등을 주력 제품으로 생산하는 업체
	LS산전	전기, 전자, 계측, 정보 및 자동화기기류와 동관련제품의 제조, 판매 및 유지보수 업체
Connecting Gas Pipe	동양철관	강관 전문 생산업체. 후판(Plate)과 코일(Coil)을 원재료로 가스관, 송유관, 일반배관, 강관말뚝, 나관, 이형관 등을 제조, 판매
	미주제강	강관제조 전문업체, 스테인리스강관, 일반탄소강관, 스파이럴 강관
	코센	스테인리스강관 제조 및 유통 업체
	엔케이	고압가스 용기생산 업체
	대동스틸	포스코의 열연제품 지정판매점으로 열연제품 및 후판을 절단가공하여 생산, 판매하는 사업을 영위. 강관의 주원료인 열연제품을 주력으로 생산하고 있어 가스관사업 확대시 수혜 가능
	하이스틸	강관 전문 제조, 판매 업체. 세경관, 소경관부터 원유, 가스수송이 가능한 60인치 대구경 후육강관까지 다양한 제품을 생산 중. 심해저용 후육관이 KS인증과 미국석유협회(API) 인증 획득
	삼현철강	POSCO 열연판매점으로 가스관과 직접적 수혜가 예상되는 강관의 주원료인 열연제품을 판매 중

Table A1-2. The list of firms involved in economic cooperation with North Korea (cont'd)

Construction / Railway	**남광토건**	**개성공단에 현지법인인 남광엔케이㈜를 설립하여 개성공단 내 건축공사 수행. 건축, 토목, 플랜트, 철구 사업 영위하는 건설업체**
	삼부토건	국내 도급공사 및 자체공사 분양사업을 영위하는 중견 건설업체. 남북철도 및 도로 관련 사업 영위
	금화psc	플랜트 전문 건설업체, 발전소, 제철소 등
	도화엔지니어링	토목, 건축, 산업설비, 조경 및 환경관련사업 설계 및 자문 업체
	현대제철	봉형강과 철도 레일 생산업체
	우원개발	토공사업 전문 건설업체. 주요 사업분야는 도로공사, 산업단지조성공사, 철도공사, 지하철공사, 특수공법공사, 하천공사, 항만공사 등
	금호산업	**개성공단 종합지원센터 건설 경험**
	일신석재	건축석재 가공 및 판매, 석산개발 및 채석
	에코마이스터	철도차량 차륜가공기계 및 계측·검수 장비 공급
	현대건설	**금강산 면회시설, 평양 정주영체육관, 경수로 공사 등 경험**
	대우E&C	**경수로 공사 수행 경험**
	GS건설	종합 인프라 건설 실적 국내 상위 기업, 남북 인프라협력 준비
	삼성물산	도로, 항만, 플랜트 건설 실적 국내 상위 기업, 남북 인프라협력 준비
	한국종합기술	**종합 토목 건설 엔지니어링 전문업체로 철도, 발전시설 등 북한 인프라 구축 엔지니어링 진출 계획, 개성공단 폐기물처리 수주 경험**
	대림산업	40여개국에서 건축, 토목, 플랜트 등 다양한 프로젝트 수행, 북한 종합 인프라 구축 참여 기대
	동양	건설 건재 회사, 레미콘 생산 등
	푸른기술	금융자동화, 역무자동화 기기 생산 업체로 남북경협 시 철도 역무자동화 기기 공급 기대
	일성건설	재정비 및 재개발, 해외 토목 사업
	현대비앤지스틸	현대자동차 자회사로 스테인리스 냉연강판 생산업체, 철도 외장재 공급
	이화공영	토목, 건축, 설비공사 기업, 파주에 대규모 토지 보유
	희림	**건축 설계 및 건설사업관리 업체, 개성공단 시범단지 공장 설계 등 대북사업 수행한 경험**
	부산산업	레미콘 생산 전문 업체, 철도 콘크리트 침목 생산 업체 '태명실업'과 '티엠트랙시스템'이 계열사
	유신	인프라 설계 및 기술조사, 타당성조사
	대아티아이	철도신호제어 시스템 전문업체. 철도신호제어시스템 시장의 선도기업으로 상위권의 시장점유율 유지 중
	대호에이엘	현대로템에 철도차량을 제작해 공급하는 1차 협력사. 2011년 8월 철강소재 및 철도차량 사업부를 물적 분할해 신설회사인 (주)대호하이텍을 설립
	현대로템	철도차량 제조 및 판매
Processing trade	DB하이텍	수탁 반도체 제조 업체
	동부씨엔아이	DB Inc의 전신, 정보기술 솔루션 및 아웃소싱 전문기업, DB 하이텍 최대주주
	한국단자공업	**단자 등 전기 부품을 북한에 원부자재를 제공해서 위탁가공 생산**
Joint Venture	**마니커**	**닭고기 가공업체, 과거 북한에 육계농장 설립 추진**
	삼천리자전거	**1997년 남북경제협력사업 선정, 해주 자전거공장 건설 추진**

Table A1-2. The list of firms involved in economic cooperation with North Korea (cont'd)

Energy Resource exploration	혜인	에너지동력 및 종합건설기계 제조 업체, 동력장비, 광산장비 제작으로 자원개발 사업 추진 계획
	LG상사	해외자원개발, 산업재 수출입, 플랜트 및 인프라 시설 투자, 건설 프로젝트
	포스코대우	포스코 계열의 종합상사, 국제무역, 해외 에너지 자원 개발, 해외 인프라 프로젝트 등
	현대종합상사	국제무역, 에너지 자원개발 등
Other Infrastructure	성신양회	시멘트 생산 전문 업체, 해외 항만 개발 사업 다수에 참여한 경험
	한일현대시멘트	시멘트 생산 전문 업체, 각종 인프라 구축 참여 기대
	HDC	종합 인프라, 부동산 기업으로 북한 인프라 및 도시 개발 관련 수주 기대
	유진기업	레미콘 생산 업체, 도로 건설 관련 경협주로 지목
	한국석유	아스팔트류, 솔벤트, 건축자재 관련 업체, 인프라 구축 시 아스팔트 수요 예상
	코오롱글로벌	토목 종합건설 사업, 철강 자원 분야 무역 사업
General trade	**효성**	**1989년 북한산 전기동 200톤 수입 경험**

Second, we employ alternative panel specification with lagged dependent variable and time-varying sensitivity measures in Table A1-3. The figures in column (1), (2) and (3) are estimated coefficients from pooled OLS model, one-way fixed effect model and two-way fixed effect model respectively. We do not estimate a dynamic panel model, such as system GMM, because we find that the serial movement of stock return is close to the random walk, and our sample has relatively long time coverage.

Table A1-3. Alternative Panel Specification

	POLS (1)	One-way FE (2)	Two-way FE (3)
One-period lagged stock return	-0.0336*** (0.0033)	-0.0287*** (0.0034)	-0.0312*** (0.0037)
GPRNK * Foreigner ownership	0.0052*** (0.0016)	0.0050*** (0.0018)	0.0062*** (0.0018)
GPRNK * log(asset)	-0.0145*** (0.0022)	-0.0150*** (0.0023)	-0.0181*** (0.0023)
GPRNK * (Fixed asset/Total asset)	-0.0092 (0.0132)	0.0011 (0.0144)	-0.0046 (0.0140)
GPRNK * Ecoop dummy	-0.0726*** (0.0107)	-0.0766*** (0.0126)	-0.0790*** (0.0128)
GPRNK * Defense dummy	-0.0186 (0.0129)	-0.0246 (0.0155)	-0.0231 (0.0149)
Number of Observations	2.233E+05	2.233E+05	2.233E+05
Adjusted R2	0.0606	0.0701	0.1671
Stock return at t-1	Yes	Yes	Yes
Other controls	Yes	Yes	Yes
Firm fixed effects	No	Yes	Yes
Time fixed effct	No	No	Yes

Notes : The figures in the table are OLS coefficients and the figures in the parentheses are robust standard erros clustered at the firm level. *, **, *** indicates statistical significance at the 10%, 5%, 1% level, respectively.
We estimate equation with one-month lagged stock return on the right hand side, and the firm-level explanatory variables are allowed time-varying. We control serial variables (EPU Index of South Korea, monthly return in Dow Index and Won-Dollar exchange rate) in column(1) and (2), which replace with time fixed effect in column (3).

Finally, Table A1-4 considers the effect at the tale of GPRNK index. We compare the regression of stock return on firm characteristics from the 10 highest-GPRNK periods and 10 lowest-GPRNK periods. As with the baseline results, the periods of high threat from North Korea exhibits a greater coefficient of foreign ownership and smaller coefficients of asset size and economic cooperation dummy than the periods of low threat. It is interesting to note that companies with a high share of exports in their sales enjoyed relatively good returns during periods of high GPRNK. From this, we can suggest that the more a company relies on its overseas business, the less sensitive its stock return to country-specific risks.

Table A1-4. Covariates of Stock Return at the Tales of GPRNK

Dependent Variable : Monthly Stock Return	GPRNK		
	Highest 10 periods	Lowest 10 periods	Difference
Foreigner ownership	-0.0005	-0.0042***	0.0037***
	(0.0008)	(0.0009)	(0.0012)
Asset size	-0.0041***	0.0027**	-0.0068***
	(0.0009)	(0.0012)	(0.0015)
Fixed-to-total	-0.0142***	-0.0096	-0.0046
	(0.0050)	(0.0067)	(0.0084)
Economic cooperation	0.0016	0.0450***	-0.0434***
	(0.0039)	(0.0072)	(0.0082)
Defense industry	0.0046	0.0083	-0.0037
	(0.0053)	(0.0067)	(0.0085)
Export/Sales	0.0147***	-0.0042	0.0189***
	(0.0034)	(0.0045)	(0.0056)
Book-to-Market	0.0164***	0.0049**	0.0115***
	(0.0017)	(0.0022)	(0.0028)
Beta	-0.0002	-0.0253***	0.0251***
	(0.0024)	(0.0050)	(0.0055)
Leverage	-0.0030	0.0138*	-0.0168*
	(0.0055)	(0.0074)	(0.0092)
ROA	0.1127***	0.2239***	-0.1112**
	(0.0268)	(0.0464)	(0.0536)
Number of Observations	18664	18047	
Adjusted R2	0.0801	0.0922	
Time-varing firm-level controls	Yes	Yes	
Time fixed effects	Yes	Yes	

Notes : The figures in the table are fixed effect OLS coefficients and the figures in the parentheses are robust standard erros clustered at the firm level. *, **, *** indicates statistical significance at the 10%, 5%, 1% level, respectively. The dependent variable is monthly stock return, i.e. log(last-day's revised price)it- log(last-day's revised price)i,t-1. All columns include time fixed effects.

A2. Supplementary Materials for Chapter II

In this appendix section, I cross-check the decomposition results of Chapter II using an alternative dataset obtained from the United Nations International Trade Statistics Database (UN Comtrade). UN Comtrade provides product-level bilateral trade records at HS 6-digit classification, which is more aggregated than KITA. The two data are complementary in that KITA presents the preliminary monthly reports of China Customs while UN Comtrade provides final figures at the end of each year. Especially, the price record, which has a high possibility of error, need to be confirmed by the cross-check. Figure A2-1, Figure A2-2 and Table A2-1 show that the decomposition results from the alternative data are very similar to those of Chapter II. Figure A2-1 presents the trends of extensive margin

Figure A2-1. Extensive and Intensive Margin: UN Comtrade Data

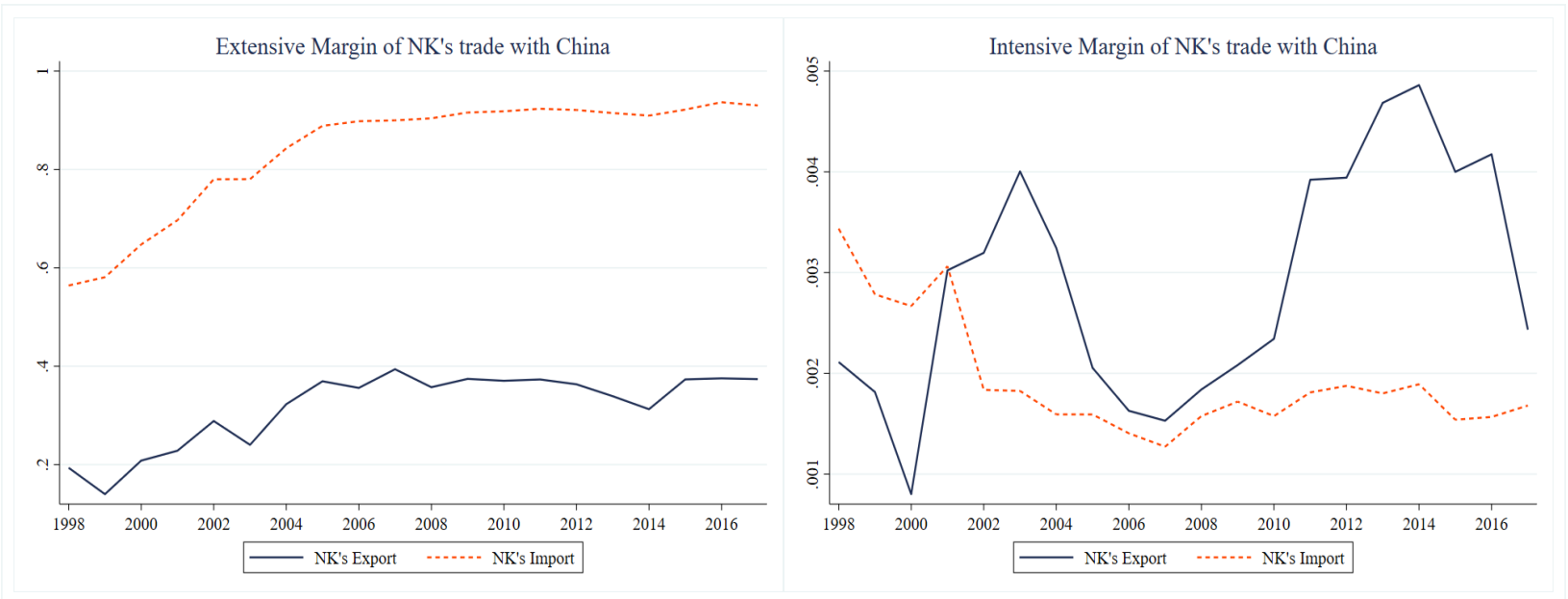


Figure A2-2. Price and Quantity: UN Comtrade Data

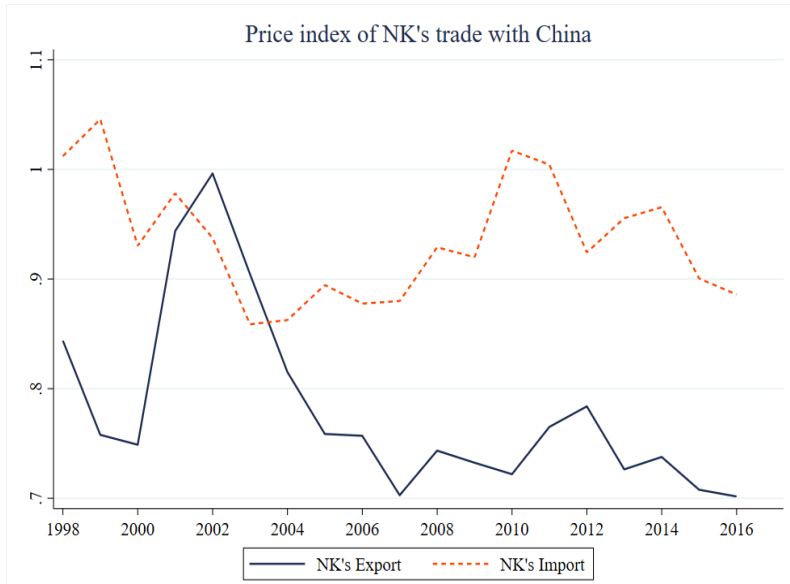


Table A2-1. Decomposing Growth rate of North Korea's Trade with China: UN Comtrade Data

Panel A. Export

	G_NK	G_ROW	G_r	G_em	G_im	G_p	G_q
1998-2003	36.18%	19.15%	17.03%	4.32%	12.79%	1.39%	11.40%
2003-2007	6.34%	18.01%	-11.67%	12.37%	-24.06%	-6.30%	-17.76%
2007-2010	22.66%	10.97%	11.69%	-2.05%	14.21%	0.90%	13.31%
2010-2013	27.80%	8.88%	18.92%	-2.95%	23.11%	0.20%	22.91%
2013-2016	-6.82%	-7.84%	1.02%	3.39%	-3.85%	-1.15%	-2.69%
2016-2017	-41.41%	12.93%	-54.34%	-0.43%	-53.98%	.	.

Panel B. Import

	G_NK	G_ROW	G_r	G_em	G_im	G_p	G_q
1998-2003	8.73%	14.96%	-6.23%	6.49%	-12.65%	-3.29%	-9.37%
2003-2007	17.10%	22.60%	-5.50%	3.56%	-9.04%	0.61%	-9.65%
2007-2010	14.86%	6.92%	7.94%	0.68%	7.13%	4.83%	2.30%
2010-2013	13.26%	8.97%	4.29%	-0.13%	4.46%	-2.08%	6.54%
2013-2016	-6.58%	-2.71%	-3.87%	0.80%	-4.63%	-2.52%	-2.11%
2016-2018	11.88%	5.52%	6.37%	-0.70%	6.99%	.	.

Note

1. All figures represents growth rates in log percentage.
2. G_NK : growth of North Korea's export to China, G_ROW : growth of ROW's export to China, G_r : relative growth of North Korea's export to China
3. G_em : growth of extensive margin, G_im : growth of intensive margin, G_p : growth in price , G_q : growth in quantity

A3. Supplementary Materials for Chapter III

A3-1. Summary of Chinese Trading Firms

Figure A3-1. Pure Trading Firms in China

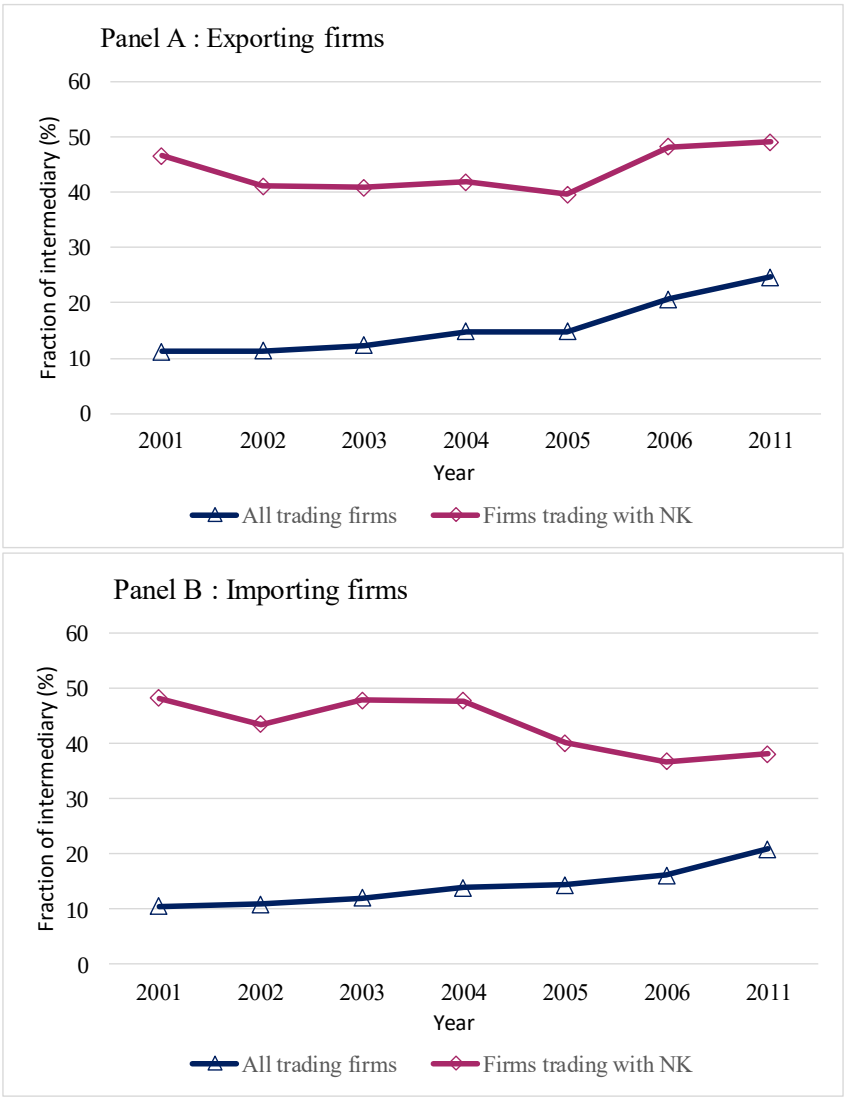


Table A3-1. Regional Distribution of Trading Firms in China: Overall

(Unit : # of firms, %)

	Export							Import						
	2001	2002	2003	2004	2005	2006	2011*	2001	2002	2003	2004	2005	2006	2011*
Guangdong	19,483	20,781	23,625	27,079	27,109	38,967	32,587	19,590	20,853	22,586	24,423	23,635	28,507	24,256
	28.6	*27.48*	*26.07*	*24.61*	*23.42*	*24.47*	*22.5*	*29.34*	*28.23*	*27.19*	*26.22*	*26.47*	*25.07*	*23.45*
Zhejiang	6,342	7,794	10,297	13,600	15,075	22,030	22,613	4,252	5,124	6,304	7,726	7,683	10,410	10,676
	9.31	*10.31*	*11.36*	*12.36*	*13.02*	*13.83*	*15.62*	*6.37*	*6.94*	*7.59*	*8.29*	*8.6*	*9.16*	*10.32*
Jiangsu	6,968	8,232	10,293	13,116	14,461	20,052	21,066	6,931	8,155	9,728	11,510	11,428	15,318	15,602
	10.23	*10.89*	*11.36*	*11.92*	*12.49*	*12.59*	*14.55*	*10.38*	*11.04*	*11.71*	*12.36*	*12.8*	*13.47*	*15.08*
Shandong	6,833	7,897	9,748	12,199	12,816	18,085	13,893	6,177	6,846	7,730	8,966	8,457	11,181	8,829
	10.03	*10.44*	*10.76*	*11.09*	*11.07*	*11.36*	*9.59*	*9.25*	*9.27*	*9.31*	*9.63*	*9.47*	*9.83*	*8.53*
Shanghai	5,600	6,568	8,572	10,630	11,437	14,497	15,140	7,995	9,082	11,034	13,031	12,596	15,976	16,708
	8.22	*8.69*	*9.46*	*9.66*	*9.88*	*9.1*	*10.46*	*11.98*	*12.29*	*13.28*	*13.99*	*14.1*	*14.05*	*16.15*
Fujian	4,306	4,609	5,104	6,058	6,287	8,036	7,034	3,858	4,318	4,386	4,692	4,392	5,350	4,472
	6.32	*6.1*	*5.63*	*5.51*	*5.43*	*5.05*	*4.86*	*5.78*	*5.85*	*5.28*	*5.04*	*4.92*	*4.71*	*4.32*
Liaoning	3,421	3,590	4,163	5,039	5,303	6,899	5,303	3,253	3,482	3,718	4,206	3,977	4,994	4,160
	5.02	*4.75*	*4.59*	*4.58*	*4.58*	*4.33*	*3.66*	*4.87*	*4.71*	*4.48*	*4.52*	*4.45*	*4.39*	*4.02*
Beijing	2,020	2,240	2,812	3,034	3,079	4,266	4,070	3,763	4,388	4,955	4,974	4,513	5,818	5,649
	2.97	*2.96*	*3.1*	*2.76*	*2.66*	*2.68*	*2.81*	*5.64*	*5.94*	*5.97*	*5.34*	*5.05*	*5.12*	*5.46*
Tianjin	1,915	2,045	2,279	2,787	3,124	4,086	3,601	2,232	2,432	2,580	2,990	2,956	3,848	3,246
	2.81	*2.7*	*2.51*	*2.53*	*2.7*	*2.57*	*2.49*	*3.34*	*3.29*	*3.11*	*3.21*	*3.31*	*3.38*	*3.14*
Hebei	1,609	1,804	2,111	2,734	2,984	3,877	3,447	1,037	1,117	1,228	1,374	1,341	1,688	1,330
	2.36	*2.39*	*2.33*	*2.49*	*2.58*	*2.43*	*2.38*	*1.55*	*1.51*	*1.48*	*1.48*	*1.5*	*1.48*	*1.29*
Anhui	824	906	1,047	1,215	1,264	1,624	1,615	605	661	768	822	778	985	1,036
	1.21	*1.2*	*1.16*	*1.1*	*1.09*	*1.02*	*1.12*	*0.91*	*0.89*	*0.92*	*0.88*	*0.87*	*0.87*	*0.88*
Hubei	760	838	978	1,194	1,260	1,676	1,773	489	503	572	618	569	769	916
	1.12	*1.11*	*1.08*	*1.09*	*1.09*	*1.05*	*1.22*	*0.73*	*0.68*	*0.69*	*0.66*	*0.64*	*0.68*	*0.89*
Henan	825	867	990	1,205	1,257	1,658	1,554	545	568	599	694	637	804	754
	1.21	*1.15*	*1.09*	*1.1*	*1.09*	*1.04*	*1.07*	*0.82*	*0.77*	*0.72*	*0.75*	*0.71*	*0.71*	*0.73*
					……..									
Total	**68,112**	**75,609**	**90,634**	**110,013**	**115,767**	**159,269**	**144,799**	**66,760**	**73,872**	**83,057**	**93,151**	**89,306**	**113,690**	**103,448**
	100	***100***	***100***	***100***	***100***	***100***	***100***	***100***	***100***	***100***	***100***	***100***	***100***	***100***

1. Figures present the number of firms located in the referred province and its fraction in total number of firms.
2. About 5% of trading firms are omitted for 2005 because trade flows are missing.
3. For 2011, about 40% of exporting firms and 30% of importing firms are omitted because of lack of regional information.

Table A3-2. Regional Distribution of Firms Trading with North Korea

(Unit : # of firms, %)

	Export							Import						
	2001	2002	2003	2004	2005*	2006	2011*	2001	2002	2003	2004	2005*	2006	2011*
Liaoning	240	271	285	309	305	400	414	87	118	106	142	150	207	219
	31.09	*33.75*	*33.49*	*35.11*	*32.66*	*27.78*	*28.26*	*40.28*	*43.38*	*40.15*	*36.79*	*40.32*	*35.88*	*34.98*
Jilin	113	116	123	125	134	190	167	75	76	86	97	96	112	122
	14.64	*14.45*	*14.45*	*14.2*	*14.35*	*13.19*	*11.4*	*34.72*	*27.94*	*32.58*	*25.13*	*25.81*	*19.41*	*19.49*
Guangdong	39	50	42	46	95	360	318	26	27	17	24	22	33	81
	5.05	*6.23*	*4.94*	*5.23*	*10.17*	*25*	*21.71*	*12.04*	*9.93*	*6.44*	*6.22*	*5.91*	*6.33*	*14.04*
Shandong	47	62	67	78	99	103	105	5	12	15	54	45	51	51
	6.09	*7.72*	*7.87*	*8.86*	*10.6*	*7.15*	*7.17*	*2.31*	*4.41*	*5.68*	*13.99*	*12.1*	*9.79*	*8.84*
Beijing	79	71	62	60	66	76	58	8	10	9	18	18	11	17
	10.23	*8.84*	*7.29*	*6.82*	*7.07*	*5.28*	*3.96*	*3.7*	*3.68*	*3.41*	*4.66*	*4.84*	*2.11*	*2.95*
Jiangsu	28	40	51	50	39	74	79	2	4	5	10	9	19	26
	3.63	*4.98*	*5.99*	*5.68*	*4.18*	*5.14*	*5.39*	*0.93*	*1.47*	*1.89*	*2.59*	*2.42*	*3.65*	*4.51*
Zhejiang	30	30	40	30	36	54	73	1	3	6	8	4	5	9
	3.89	*3.74*	*4.7*	*3.41*	*3.85*	*3.75*	*4.98*	*0.46*	*1.1*	*2.27*	*2.07*	*1.08*	*0.96*	*1.56*
Shanghai	37	40	38	38	37	45	55	4	4	9	12	10	15	29
	4.79	*4.98*	*4.47*	*4.32*	*3.96*	*3.13*	*3.75*	*1.85*	*1.47*	*3.41*	*3.11*	*2.69*	*2.88*	*5.03*
Heilongjiang	25	18	25	27	21	33	74	0	3	4	7	2	6	14
	3.24	*2.24*	*2.94*	*3.07*	*2.25*	*2.29*	*5.05*	*0*	*1.1*	*1.52*	*1.81*	*0.54*	*1.15*	*2.43*
Tianjin	30	20	19	25	20	17	17	3	4	2	3	3	7	14
	3.89	*2.49*	*2.23*	*2.84*	*2.14*	*1.18*	*1.16*	*1.39*	*1.47*	*0.76*	*0.78*	*0.81*	*1.34*	*2.43*
Hebei	19	16	20	16	15	21	21	0	2	0	5	4	5	12
	2.46	*1.99*	*2.35*	*1.82*	*1.61*	*1.46*	*1.43*	*0*	*0.74*	*0*	*1.3*	*1.08*	*0.96*	*1.92*
Henan	14	10	11	14	13	12	6	1	5	4	1	4	6	4
	1.81	*1.25*	*1.29*	*1.59*	*1.39*	*0.83*	*0.41*	*0.46*	*1.84*	*1.52*	*0.26*	*1.08*	*1.15*	*0.64*
Total	**772**	**803**	**851**	**880**	**934**	**1,440**	**1,465**	**216**	**272**	**264**	**386**	**372**	**521**	**577**
	100	***100***	***100***	***100***	***100***	***100***	***100***	***100***	***100***	***100***	***100***	***100***	***100***	***100***

1. Figures present the number of firms located in the referred province and its fraction in total number of firms.
2. About 5% of trading firms are omitted for 2005 because trade flows are missing.
3. About 40% of exporting firms and 30% of importing firms are omitted for 2011 because of lack of regional information.

Table A3-3. Ownership Structure of Trading Firms in China

(Unit : # of firms, %)

	Export						Import					
	Overall			NK			Overall			NK		
	2003	2006	2011*	2003	2006	2011*	2003	2006	2011*	2003	2006	2011*
Household Industries	0	1,982	2	0	42	0	0	71	1			
	0	*1.25*	*0*	*0*	*2.92*	*0*	*0*	*0.06*	*0*			
Cooperative Enterprises	3,894	2,936	1,418	7	5	3	3,808	2,559	1,058	2	1	4
	4.3	*1.85*	*1.57*	*0.82*	*0.35*	*0.46*	*4.58*	*2.25*	*1.67*	*0.76*	*0.19*	*1.32*
Joint Ventures	19,314	21,623	12,121	89	84	55	17,661	17,306	8,609	14	47	26
	21.31	*13.61*	*13.45*	*10.46*	*5.83*	*8.36*	*21.26*	*15.23*	*13.62*	*5.3*	*9.02*	*8.58*
Foreign-owned Enterprise	30,541	45,808	29,947	64	96	47	33,374	45,831	27,287	29	66	55
	33.7	*28.82*	*33.22*	*7.52*	*6.67*	*7.14*	*40.18*	*40.34*	*43.17*	*10.98*	*12.67*	*18.15*
State-owned Enterprise	12,540	10,235	5,430	438	292	154	10,990	8,609	4,714	127	89	60
	13.84	*6.44*	*6.02*	*51.47*	*20.28*	*23.4*	*13.23*	*7.58*	*7.46*	*48.11*	*17.08*	*19.8*
Collective firms	5,748	5,147	2,751	66	52	36	3,267	2,863	1,473	21	16	10
	6.34	*3.24*	*3.05*	*7.76*	*3.61*	*5.47*	*3.93*	*2.52*	*2.33*	*7.95*	*3.07*	*3.3*
Private Enterprise	17,908	71,055	38,427	171	856	362	11,418	35,514	19,912	71	300	148
	19.76	*44.71*	*42.63*	*20.09*	*59.44*	*55.02*	*13.75*	*31.26*	*31.5*	*26.89*	*57.58*	*48.84*
Others	689	147	66	16	13	1	2,539	865	158	0	2	0
	0.76	*0.09*	*0.04*	*1.88*	*0.9*	*0.11*	*3.06*	*0.76*	*0.25*	*0*	*0.38*	*0*
Total	**90,634**	**158,933**	**90,150**	**851**	**1,440**	**658**	**83,057**	**113,618**	**63,212**	**264**	**521**	**303**
	100	***100***	***100***	***100***	***100***	***100***	***100***	***100***	***100***	***100***	***100***	***100***

1. Figures present the number of firms located in the referred province and its fraction in total number of firms.
2. Some of observations have missing information about company type. For 2011, about 60% of firms are omitted both in export and imports.

A3-2. North Korea's Indirect Exports via China: Linear Probability Regression

Table A3-4. Evidence of North Korea's Indirect Export through Chinese Firms: Linear Probability Model

Dep. Variable : **1**(Import from North Korea>0)	Year : 2002			Year : 2006			Year : 2011		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Export dummy	0.0093*** [6.25]	0.0040*** [4.85]	0.0081*** [7.63]	0.0087*** [7.51]	0.0042*** [5.85]	0.0086*** [8.28]	0.0086*** [6.68]	0.0029*** [3.89]	0.0082*** [6.60]
Export to South Korea dummy		0.0719*** [8.30]	0.0739*** [8.43]		0.0535*** [7.10]	0.0555*** [7.21]		0.0750*** [7.24]	0.0780*** [7.34]
Export to Japan dummy		-0.0164*** [-7.28]	-0.0144*** [-6.75]		-0.0112*** [-5.93]	-0.0097*** [-5.68]		-0.0154*** [-6.39]	-0.0145*** [-6.52]
Export to US dummy			-0.0112*** [-6.53]			-0.0103*** [-5.72]			-0.0113*** [-5.41]
Export to EU dummy			-0.0091*** [-5.35]			-0.0081*** [-6.78]			-0.0091*** [-6.05]
Log of import value	0.0004*** [4.04]	0.0003*** [3.84]	0.0003*** [3.85]	0.0005*** [4.70]	0.0004*** [4.13]	0.0004*** [4.19]	0.0014*** [6.41]	0.0012*** [6.51]	0.0012*** [6.57]
Log of import price	-0.0008*** [-5.36]	-0.0006*** [-4.71]	-0.0006*** [-4.80]	-0.0014*** [-6.71]	-0.0013*** [-6.71]	-0.0013*** [-6.80]	-0.0016*** [-6.73]	-0.0014*** [-6.87]	-0.0014*** [-6.89]
Product FE	Y	Y	Y	Y	Y	Y	Y	Y	Y
Company type dummies	Y	Y	Y	Y	Y	Y	Y	Y	Y
Province dummies	Y	Y	Y	Y	Y	Y	Y	Y	Y
Number of observations	2.121E+05	2.121E+05	2.121E+05	2.838E+05	2.838E+05	2.838E+05	4.226E+05	4.226E+05	4.226E+05
Number of products	463	463	463	508	508	508	528	528	528
Adjust R2	0.3508	0.3656	0.3666	0.4259	0.4342	0.4352	0.1946	0.2166	0.2183

Notes : This table examines the relationship between firms'import from North Korea and exports to the other countries, using cross-firm variations within product. The outcome variable is a binary response that have value 1 if a firm import positive value of a product from North Korea. The coefficients are estimated based on Linear Probability model. The figures in the brackets are t-statistics calculated based on product-clustered standard erros. Column (1)~(3), (4)~(6) and (7)~(9) presents regression result in 2002, 2006 and 2011, respectively. All columns include product fixed effects, province fixed effects and company type dummy. *, **, *** indicates statistical significance at the 5%, 1%, 0.1% level, respectively.

Table A3-5. Evidence of North Korea's Indirect Export through Chinese Firms: by Industry LPM

Dep. Variable : 1(Import from North Korea>0)	Mining			Textile			Fish		
	2002	2006	2011	2002	2006	2011	2002	2006	2011
Export dummy	0.0095	0.0286	0.0440	0.0135***	0.0073***	0.0443***	0.0208	0.0641**	0.0274
	[0.51]	[1.23]	[1.93]	[3.91]	[3.99]	[6.88]	[1.49]	[2.83]	[0.77]
Export to South Korea dummy	-0.0165	0.0602	0.0783	0.0759***	0.0457***	0.1360***	0.1506***	0.0859**	-0.0028
	[-0.18]	[1.13]	[1.50]	[8.27]	[3.50]	[7.39]	[5.69]	[3.05]	[-0.12]
Export to Japan dummy	-0.0195	-0.0101	-0.0056	-0.0271***	-0.0111**	-0.0407***	-0.0211	-0.0716**	-0.0139
	[-0.79]	[-0.30]	[-0.17]	[-8.56]	[-3.05]	[-6.91]	[-1.00]	[-2.93]	[-0.30]
Log of import value	-0.0023	-0.0045*	0.0014	0.0036***	0.0030***	0.0117***	-0.0009	-0.0056	0.0076
	[-2.02]	[-2.40]	[0.91]	[5.59]	[7.24]	[8.32]	[-0.36]	[-1.76]	[1.44]
Log of import price	-0.0113**	-0.0222***	-0.0063***	-0.0021***	-0.0036***	-0.0136***	0.0075	-0.0141	-0.0156
	[-3.27]	[-3.61]	[-5.61]	[-4.28]	[-4.77]	[-7.93]	[1.13]	[-1.41]	[-1.07]
Product FE	Y	Y	Y	Y	Y	Y	Y	Y	Y
Company type dummies	Y	Y	Y	Y	Y	Y	Y	Y	Y
Province dummies	Y	Y	Y	Y	Y	Y	Y	Y	Y
Number of observations	3,320	3,513	3,766	16,497	26,161	31,252	1,889	1,958	718
Number of products	40	45	39	93	118	146	36	38	17
Adjust R2	0.655	0.7122	0.6039	0.5838	0.7767	0.5555	0.7187	0.6158	0.6688

Notes : This table examines the relationship between firms'import from North Korea and exports to the other countries by industy. The outcome variable is a binary response that have value 1 if a firm import positive value of a product from North Korea. The coefficients are estimated based on Linear Probability model . The figures in the brackets are t-statistics calculated based on procuct-clustered standard erros. Column (1)~(3), (4)~(6) and (7)~(9) presents regression result from the sample restricted to mining industry, textile industry and fishing industry respectively. All columns include product fixed effects, province fixed effects and company type dummy. *, **, *** indicates statistical significance at the 5%, 1%, 0.1% level, respectively.

국문초록

국제정치적 갈등이 남북한 경제에 미치는 영향: 주식시장과 무역에 대한 분석

본 논문은 국제정치적 갈등의 경제적 영향에 대해 남북한의 사례를 중심으로 살펴본다. 특히 북한 관련 리스크가 남한의 주식 시장에 미치는 영향과 경제 제재가 북한의 무역에 미치는 영향에 주목하였다. 전체 논문은 개별적인 소주제를 다루는 세 편의 실증 연구로 구성된다.

첫 번째 장에서는 남한의 기업 주가 수익률이 북한 리스크에 어떻게 반응하는지 분석한다. 이를 위해 남한 언론의 북한 관련 보도 자료를 사용하여 월별 '북한 리스크 지수'를 작성하였다. 이 지수는 남북 관계의 긴장이 확대되거나 완화되는 경우 언론보도에 등장할 것으로 기대되는 키워드를 포함한 기사의 빈도수를 바탕으로 산출된다. 1999~2018 년의 언론 보도자료를 분석한 결과, 북한 발 리스크는 핵/미사일 실험, 군사도발 등 이벤트 시점에 급증하며, 반대로 정상회담, 6 자 회담 등 대화의 시기에는 감소하는 것으로 나타났다. 기업 주가 수익률을 종속변수로 한 회귀분석에서는 국내 투자자의 주식 보유 비율이 높은 기업일수록, 자산 규모가 크고 고정자산의 비중이 높은 기업일수록, 남북경협에 관여한 경험이 있는 기업일수록 북한 관련 리스크에 민감하게 반응하는 것으로 나타났다.

두 번째 장에서는 북한에 부과된 주요 경제 제재가 무역에 준 영향을 무역의 질적 측면을 중심으로 분석한다. 우선 1998~2018 년의 북한-중국 간 무역을 외연적 확장 수준(extensive margin), 상대 가격(relative unit price), 물량(quantity)으로 분해하고, 이 중 무역의 질적 측면으로 볼 수 있는 외연적 확장 수준과 상대 가격 지수의 변화에 주목하였다. 이를 통해, 북한의 대중 수출이 지난 20 년간 양적으로 성장하였을 뿐 질적으로는 정체되어 있거나

오히려 후퇴했다는 사실을 확인하였다. 회귀분석에서는 북한의 무역을 직접적으로 타격하고자 한 한국과 일본의 독자 제재 및 2017 년 UN 안보리에서 결의된 다자 제재를 핵심 설명 변수로 설정하였고, 분석 방법으로는 전기 종속 변수가 포함된 동적 패널 모형(dynamic panel model)을 사용하였다. 추정 결과, 2017 년 UN 의 제재가 북한의 대중 수출에서 품목의 외연적 확장 수준을 축소시킨 것으로 나타났다. 또한 2003 년 일본의 제재는 중국 수입 시장에서 북한 생산품의 상대 가격을 유의하게 하락시킨 것으로 추정되었다. 추가적인 회귀분석에 따르면, 이러한 상대 가격 하락은 북-중 간 가격 협상력의 차이에서 기인한다. 이 연구 결과는 북한에 대한 무역 제재가 다른 주요 교역국과의 거래 관계를 차단하고 중국에 대한 의존도를 지나치게 높이면서 암묵적 비용을 발생시키고 있음을 시사한다.

마지막 장에서는 남한의 5.24 조치를 회피하기 위한 북-중 간의 우회무역 규모를 추정하였다. 이 연구는 중국의 기업-품목 단위의 자료를 사용하여 현재까지 북-중 무역에 대한 연구 중 가장 미시적 수준의 실증분석 결과를 제시한다. 분석 방법은 이중 차분법(difference-in-difference estimation)을 사용하였으며, 대 남한 수출과 대 북한 수입이 동시에 발생한 기업-품목들을 처치그룹으로 설정하여 2010 년 전후의 변화를 추정하였다. 분석 결과, 북한의 중국을 경유한 남한으로의 간접 수출은 2010 년 5.24 조치 이후 유의하게 증가한 것으로 나타났다. 산업별로 나누어 보면, 이러한 우회 무역은 주로 의류 임가공 부문에 집중되어 있으며 그 규모는 제재 이후 북한의 대남 직접 수출 감소분의 25%에 달하는 것으로 추정되었다.

주요어: 갈등, 남북관계, 경제 제재, 주가 수익률, 북-중 무역, 무역의 질, 간접 수출

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